COMBUSTION

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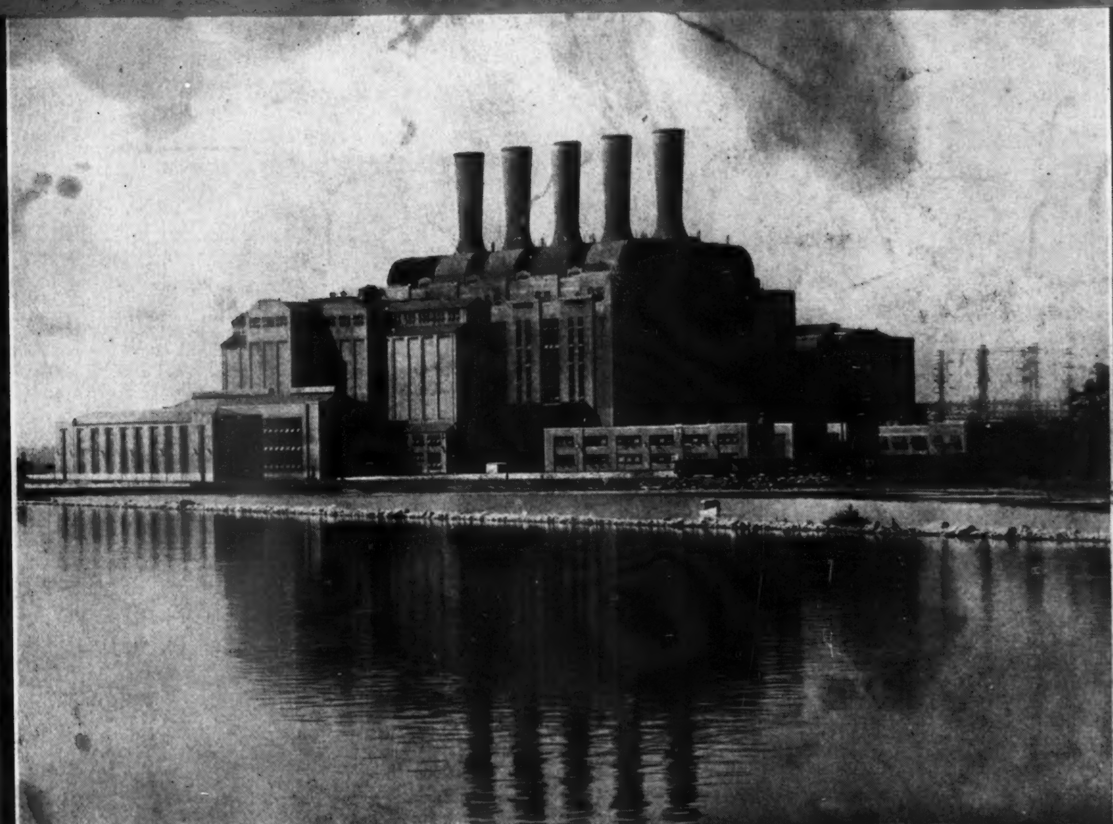

TRENTON CHANNEL PLANT, DETROIT EDISON COMPANY

Feed Water Treatment of Special Importance at High Rates of Evaporation

By A. R. MUMFORD

The Writing of Technical Papers

By W. L. DE BAUFRE

Placing a Steam Plant in Commission

By WILLIAM S. JOHNSTON

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W. SENNHAUSER • K. TOENSFELDT • DAVID BROWNLIE • B. J. CROSS

A TRIBUTE TO RELIABILITY

New York Steam Obtains Grand Central Contract

To Supply Group of Buildings; Road Abandons Own Plants

Arrangements to supply the entire steam requirements of 1,500,000,000 pounds annually to the Grand Central group of buildings have been completed by the New York Steam Corporation. The buildings included in the group extend from Forty-second to Fiftieth Streets and from Madison to Lexington Avenues, according to the statement issued by the corporation yesterday.

With the addition of the Grand Central group, the New York Steam Corporation will supply practically every important building in the midtown section.

The buildings included in the Grand Central group either are owned by the New York Central Railroad Company or have been erected by others on property leased from the railroad company for a long term of years. For some years the major steam requirements of the buildings have been supplied from two large steam generating stations owned and operated by the railroad company and located at Park Avenue and Fiftieth Street and at Lexington Avenue and Forty-third Street. Steam has been distributed through a system of pipe lines occupying land privately owned by the railroad company. The railroad company has been maintaining a break-down service contract with the New York Steam Corporation to insure continuity of service.

After a thorough study of the reliability of the steam corporation's service and an analysis of costs, the railroad company has decided to abandon its two stations and, together with the New York, New Haven & Hartford Railroad, has entered into a contract with the New York Steam Corporation.

View of Grand Central Zone, New York, containing the Grand Central Group of buildings whose steam requirements will amount to 1,500,000,000 pounds annually

"a thorough study of the reliability of the steam corporation's service"

The decision of the New York Central to abandon existing power plants and contract with the New York Steam Corporation for service, is a great tribute to the reliability of the service furnished by this company.

Combustion Engineering Corporation, has for many years, supplied fuel burning and steam generating equipment to the New York Steam Corporation.

In the Kip's Bay Station, their nearest plant to the Grand Central Group of buildings, are installed — C-E Boilers — Ladd Type, Lopulco Pulverized Fuel Systems, C-E Fin Furnaces, C-E Air Preheaters and Raymond Pulverizers.

Kip's Bay Station is designed for an ultimate capacity of approximately 5,000,000 pounds of steam per hour and has already established records for steam production per unit and steam production per square foot of floor area.

COMBUSTION ENGINEERING CORPORATION

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COMBUSTION

Vol. 1 SEPTEMBER 1929 No. 3

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COMBUSTION

Vol. 1 September 1929 No. 3

Power and Heat Should Be Coordinated

DAVID MOFFAT MYERS

THE ultimate in the production of wealth and efficiency can be attained only by intelligent coordination of all the forces involved.

In the field of Power these forces are working separately and are not coordinated with the exception of a few minor and scattered pioneer examples.

The Power Industry produces energy exclusively, but at a great loss of unused heat.

The Manufacturing Industry produces heat for warming and process and makes or buys its energy, the same being true of great blocks of office and hotel buildings in cities. This group, if it were permitted to trade freely in the commodities of heat and energy with the Power Industry, could not only greatly augment its own efficiency, but add equally to the efficiency of the Power Group.

In this day of high steam pressures, enough by-product energy can often be made from process and heating steam to supply a substantial surplus more cheaply than it can be generated by a modern central station. The Power Company could well afford in such a case to install the required unit in the Industrial Plant.

A great steam company and a great power company have plants side by side. The one is making steam without producing its valuable quota of by-product energy. The other is throwing away the bulk of its steam heat to warm up the river. What a chance for a merging of interests for mutual profit and lower rates for the Public!

When electrical energy is sold to a consumer who could generate that energy more cheaply himself, the production of wealth in the country has been retarded at the expense of that consumer. And if a consumer makes his own power when he can buy it more cheaply, he is decreasing the community wealth at the expense of the power industry.

The last decade has witnessed marvelous progress in the conversion of heat into energy. The Power Industry has been the natural leader in this field. It is true and also natural that the manufacturing industry is years behind in the modernization of its plants.

In both fields it is true that a plant designed ten years ago needs careful scrutiny to check against preventable waste in the light of present day standards.

But the greatest opportunity for progress in the next decade lies not in higher steam pressures, but rather in a new conception and application of the cooperative principle—a spirit of free trade in the commodities of heat and energy, cooperation of the human organizations and coordination of physical equipment.

Such a spirit, intelligently mobilizing and coordinating all the forces involved, will bring forth a substantially higher standard of overall efficiency in the production of wealth and service to the public.

David Moffat Myers

Consulting Engineer, New York

E D I T O R I A L

Tomorrow's Executives

SOME years ago, a well known newspaper columnist defined a wise man as "One who can keep his sixteen year old son from thinking he's a damn fool."

In the recent Thomas A. Edison scholarship contest, in which forty-nine boys, representing every state, participated, every contestant finished with an average above 60—the passing mark. The winner, Wilber B. Huston, sixteen years old, received a grade of 92.

The examination embraced specific subjects such as mathematics, physics and chemistry, supplemented by general queries the answers to which were intended to give some index as to the character, judgment and initiative of the contestants.

The list of questions has been given in full by the newspapers of the country—a few are reprinted below:

"When you read the names of the following persons what facts are associated with them in your mind? Mendeleff, Davy, Perkin, Faraday, Curie, Priestley, Gaylussac, Dalton, Solvay, Ramsay, Lavoisier.

Name the use of the following: Galvanometer, vernier, oscillograph, pantograph, micrometer, pyrometer.

How would you prepare and collect in a reasonably pure state the following gases: (A) Nitrogen, (B) Ammonia, (C) Chlorine?

A set of bottles was known to contain the following powdered substance: Blue vitriol, ultramarine, manganese, ioxide, carbon, potassium chlorate, but the labels on the bottles have been destroyed. What tests would you apply, mental as well as physical, which would enable you to correctly and quickly relabel the bottles?

Balance the following equation by inserting the proper coefficients. AGNOS plus NA2HPO4 equal AG3PO4 plus NANO3 plus HNO3.

It would be difficult to select a group of forty-nine engineering executives, *all* of whom could make a passing grade of 60 in such an examination—yet every one of the forty-nine school boy contestants exceeded this mark.

There are surprisingly few executives—men who have arrived—who could equal or excel a grade of 92, yet this was the average of the winner, a lad of 16, who is just starting out on the long journey toward the top.

Experience is an invaluable teacher. Business acumen, mature judgment, and breadth of vision are gleaned from the field of experience and result from personal contact with the successes and failures incident to the actual doing of things worth while.

However, text books point the way and bring to those who master them the wealth of traditional knowledge of those who have gone before.

Modern education is keeping pace with the increasing intricacies of modern engineering. It has been said that the high school graduate of today has a broader understanding of practical science than the college graduate of fifty years ago.

These forty-nine school boys give promise that the youth of America is entering business and the professions well equipped to assist and later to succeed those who now lead the way.

Such youth has much to offer to the advancement of engineering—and such youth will be served.

Public Ownership on a Decline

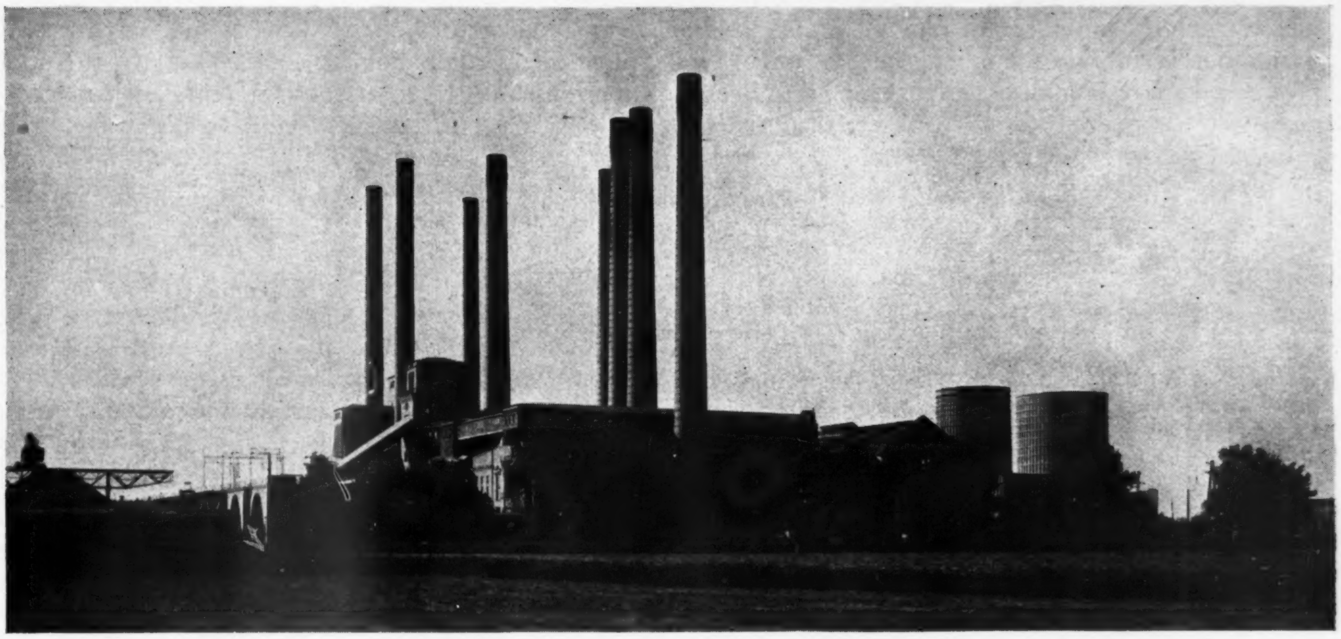
THE pother in the newspapers over the terrible power trusts naturally leads us all to surmise that where there is so much smoke there must be some fire. It is alleged that the power companies are a menace to our good old American Institutions. It is hinted that public ownership must seriously be considered as a remedy. Apparently, in some way the power companies are taking money out of our pockets. If State or Federal Commissions cannot adequately control these corporate monsters, then it seems that public ownership must be resorted to.

If all that is so, then our financial despoilers must include some three million individuals who now own public utility securities. Of late, the utility companies have raised their money for expanding their services directly from their customers. If spoliation is indulged in, it looks like the customer-investor is despoiling himself, which is interesting.

State Commissions are quite effective in keeping rates consonant with cost plus a reasonable profit. Both consumers and companies are continually availing themselves of this rational jurisdiction.

As for municipal ownership: over 1000 municipal electric plants have relinquished control during the last 14 years. In 1928 there were 172 such plants sold to private systems. It is obvious that competition forced the change. Customers of public utility companies are serviced by a system of sympathetic personal contacts more perfectly worked out than in any other class of corporation activity.

It would seem that public ownership is on a decline. No matter what pother is raised by our vociferous press, our consuming and investing public is literally putting its money down on private ownership of public utilities to win.



Trattendorf Power Station of the Elektrowerke A. G.

Lignite Power Stations in Germany

Outstanding Developments That Constitute One of the Greatest Advances in the Science of Combustion

By David Brownlie, London

THE total world production of lignite is approximately 200,000,000 metric tons per annum, which corresponds to about 14 per cent of the combined anthracite, bituminous coal, sub-bituminous coal, and lignite production, amounting roughly to 1,400,000,000 metric tons per annum. Germany mines and consumes about 160,000,000 tons of lignite every year, that is 80 per cent of the world production, and if Czecho-Slovakia (Bohemia), forming part of Germany before the World-War, is included, the total is about 180,000,000 tons, or 90 per cent.

It will be obvious, therefore, that Germany is the only country in the world that has so far succeeded in developing the lignite industry upon a gigantic scale, although the Yallourn Power Scheme in Australia, for the development of Morwell lignite, now appears to be a commercial success, with a consumption of about 10,000 tons of lignite per 24 hours, both for use under steam boilers at the Yallourn Power Station, supplying electricity to Melbourne 90 miles away, and also for briquetting.

It is well known of course that great attention is being given from the experimental and research point of view to the development of lignite in many other countries of the world, particularly, for example, in certain western parts of the United States, in Canada, particularly in Saskatchewan, and in the Landes area in France. Among the installations in the United States are several modern central stations using lignite in pulverized form, and quite a number of smaller power and industrial plants.

The enormous rate of increase in the use of lignite in Germany is undoubtedly one of the greatest achievements in the world of combustion, and it is interesting to note for example that the total amount of lignite mined in the German Empire in the year 1880 was just over 12,000,000 tons. This had risen to approximately 83,500,000 tons in 1914 when the War started, but since 1918 even greater attention has been concentrated upon the utilization of German lignite because of the loss of coal-bearing territories such as the Sarre, Czecho-Slovakia, and Poland.

The utilization of lignites for steam electric power generation is much further advanced in Germany than in any other part of Europe. Mining and burning 160 million tons of lignite annually have resulted in a distinct technique in Germany. In this article Mr. Brownlie sketches for us the high spots of the story and amplifies his text with some exceptionally good photographs.

It is hardly necessary to emphasise that the use on a commercial scale of a fuel with about 50 to 55 per cent moisture represents considerable difficulties, in spite of the fact that in Germany open-cut or strip mining can be carried out

under specially good conditions. German lignite varies considerably in quality, but as mined the proximate analysis figures are within the following range:

Fixed Carbon	11.0—29.0 per cent
Volatile Matter	21.0—30.0 per cent
Ash	2.0—10.0 per cent
Moisture	42.0—60.0 per cent
Total	100 per cent
Heating Value:	
(a) B.t.u. per lb.	3600—5760
(b) K. calories per kilo	2000—3200

With regard to the exact methods of the utilization of the 160,000,000 tons of lignite per annum in Germany, about 67 to 70 per cent (107,200,000 to 112,200,000 tons) is used for making briquettes, 18 to 22 per cent (28,800,000 to 35,200,000 tons) for combustion in the raw state, 9 to 10 per cent (14,000,000 to 16,000,000 tons) for total gasification, and 1.3 per cent (2,100,000 tons), for low temperature carbonization and other very small uses such as the extraction of Montan Wax and high temperature carbonization.

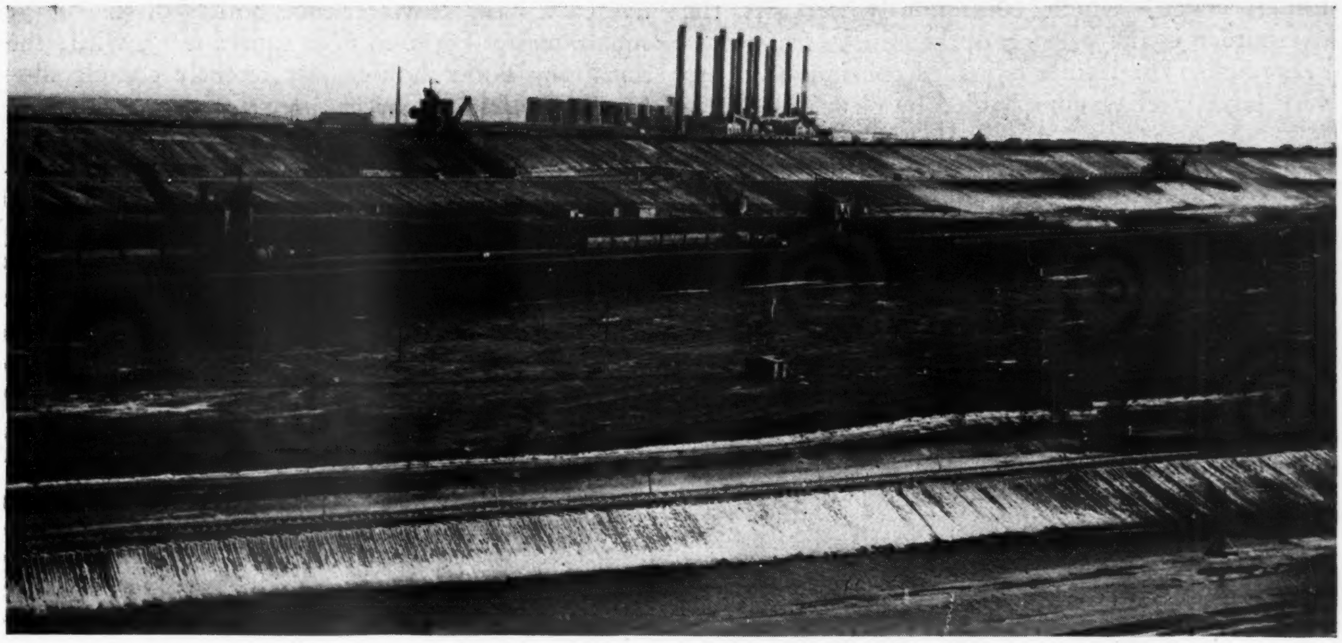
The whole subject of the utilization of lignite in Germany is of the greatest interest to fuel technologists, but certainly one of the most outstanding features is the fact that a number of the world's greatest power stations such as Golpa-Zschornewitz, Trattendorf, Lauta, Böhlen, Hirschfelde, and Fortuna Nos. 1 and 2, are being operated with raw lignite alone both in the lump condition on mechanical stokers and also in the pulverized state after drying down to the hydroscopic limit of 15 to 18 per cent moisture.

As showing the enormous development of lignite power stations in Germany, in 1927 the total production of electricity, in over 600 power stations, was about 25,000,000,000 kw. hours, with a total plant installed of about 10,000,000 kw. Of this total approximately 15 per cent represents hydro-electric power, while of the remaining 85 per cent, 35 per cent is from bituminous coal, 31 per cent from lignite, 6 per cent from mixed solid fuels, 11 per cent from gaseous fuel (largely derived from lignite), and about 1 per cent from liquid fuel. However, in 1914, the year of the War, in the case of power stations operated with fuel, about 66 per cent of the total output was obtained from bituminous coal, with less than 25 per cent from lignite, the balance being oil and other fuels, while water power was responsible for approximately 11.75 per cent of the total power output.

There are three great power station groups in Germany utilizing lignite, that is the Elektrowerke A. G. of Prussia, with an annual production of about 1,600,000,000 kw. hours and the Golpa-Zschornewitz, Trattendorf, and Lauta Stations, primarily supplying Berlin and many other towns; the A. G. Sächsische Werke of Dresden, with about 690,000,000 kw. hours, and chiefly the Böhlen and Hirschfelde Stations, and the Rheinisch-Westfaelische Elektrizitätswerke of Essen, with a production of 1,350,000,000 kw. hours and the Fortuna Stations.

In each case these groups represent a vast network of overhead transmission lines, which are now interconnected with one another and with many of the hydro-electric installations in Southern Germany, particularly in Bavaria. In addition there is included a large number of power stations using bituminous coal, of which one of the latest is the Klingenberg Station on the River Spree in Berlin. This station, which is equipped for pulverized fuel firing is certainly one of the most efficient and scientifically organized installations in the world. The first section of this plant represents an installed capacity of about 300,000 kw.

Combined multiple bucket excavator and long overhead bridge with belt conveyor for overburdens. Typical Allegemeine Transportaulagen apparatus for strip mining of lignite in Germany



View of the lignite mine adjacent to the Golpa-Zschornewitz power station, showing electrically operated multiple bucket dredger excavators used on both lignite and overburden

It would require a volume of considerable size to give any adequate description of the electricity supply, and of the electrical power stations, of Germany, while the story of the gradual growth of electricity in Berlin, a city with about 4,000,000 inhabitants, is itself an extremely complicated matter. Berlin now has four power stations belonging to the Berliner Städtische Elektrowerke, all of which use bituminous coal. These include Rummelsberg, Moabit, and Charlottenburg, in addition to Klingenberg, amounting in all to about 925,000,000 kw. hours, per annum and constituting the fourth great power group in Germany. Also the Elektrowerke A. G. of Prussia, with head offices in Berlin, now supplies the City with current from a plant of over 450,000 kw. at the Golpa-Zschornewitz, Trattendorf, and Lauta Stations, approximately 80 to 90 miles from Berlin, using lignite.

The present total demands of Berlin correspond to equipment of over 750,000 kw. and the whole matter is now managed on co-operative lines, the basic principle adopted being apparently for the long distance lignite power stations of the Elektrowerke A. G. to run on a relatively high load factor at 7000 hours per annum, and for the bituminous coal-fired stations in Berlin itself to cope with the peak demands.

Confining our attention primarily to lignite and to Golpa-Zschornewitz, Trattendorf, and Lauta, these stations are interconnected and there are two 100,000 volt overhead transmission lines to Berlin, one from Golpa-Zschornewitz and one from Lauta and Trattendorf together, which join up at Friedrichsfelde, east of Berlin, while there has just recently been added a third 100,000 volt transmission line from Golpa-Zschornewitz, going to Brandenburg and reaching Greater Berlin at Spandau.

The Golpa-Zschornewitz Station is situated in the Bitterfeld area, between Bitterfeld and Wittenberg, about 85 miles from Berlin, and the present installed plant is approximately 300,000 kw. consuming 10,000 metric tons of raw lignite per 24 hours, or roughly 3,000,000 tons per annum. The first section of this plant was erected in 1915 during the War, being 128,000 kw. including 66 water-tube boilers, each of 500 to 575 square metres (5382 to 6190 square feet) heating surface, along with 9 chimneys 100 metres (328 feet) high, 11 cooling towers, and 8 steam turbines of different sizes aggregating approximately 180,000 kw.

After the War was over, Golpa-Zschornewitz was extended to 230,000 kw. and operated under these conditions for a number of years, consuming about 8000 tons of lignite per 24 hours or say 2,250,000 tons per annum, and recently the plant has been still further increased.

As usual with these German lignite stations, the raw fuel is mined alongside by open cut or strip working, first removing the overburden and then the lignite. The exact methods vary according to the conditions, but essentially the most modern German practice, with a gigantic output of anything from 10,000 to 25,000 tons of lignite per day from a single mine, consists in the use of special multiple bucket, endless chain, "dredger" excavators, which can be electric, steam, Diesel engine, or petrol engine driven, and run either on rails or caterpillar tractor wheels. The very latest method, however, can be regarded as electric driven, multiple bucket "dredgger" excavators with caterpillar tractor wheels, both for the overburden and the lignite, and in a large number of cases the overburden dredger excavators are operating in direct conjunction with an overhead traveling belt conveyor or bridge (Abraum-

forderbrucken) which continuously deposits the overburden in another part of the mine as fast as it is excavated. The lignite is loaded continuously into very large steel wagons hauled by electric locomo-

A Liebecker multiple bucket dredger excavator, with electric drive and mounted on caterpillar tractor wheels

tives, traveling along at a greater speed underneath the discharge of the multiple bucket dredger excavator, which is also moving.

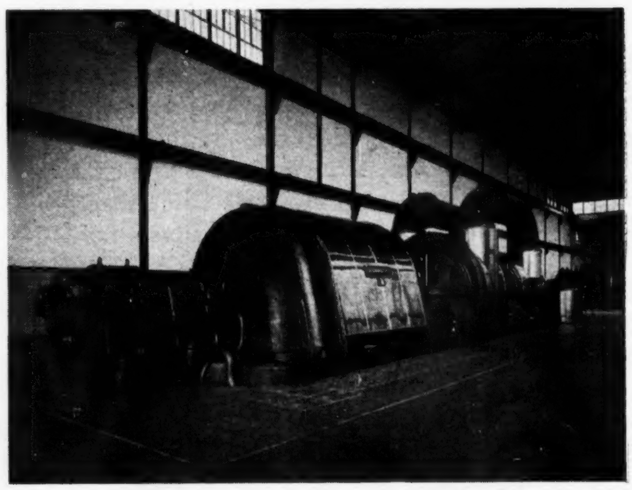
At the Golpa Lignite Mine the seams vary from 2.75 to 21.50 metres (9.0 to 70.5 feet) in thickness but average about 11.90 metres (39.0 feet). The moisture content, as mined, is 53 to 55 per cent, with a heating value in the dry state of 8300 to 9500 B.t.u. (4610 to 5294 K. calories per kilo). The average depth of the overburden is 18.0 metres (59.25 feet).

During the past few years the methods of mining at Golpa have been revolutionised on the lines

Krupp depositing machine for piling overburden on dump lignite power station of Electrowerke A. G.

indicated, and it may be stated that to-day about 10,000 tons of lignite, in addition to all the overburden, is excavated per 24 hours with about 1190 men, divided into two shifts, whereas not so long ago over 4000 men had to be employed for this work. The huge boiler plant at Golpa-Zschornewitz is divided into six separate boiler houses, of which five each have 16 water-tube boilers of 500 to 575 square metres (5382 to 6190 square feet), while the remaining boiler house—just recently completed—has 12 boilers of larger size, 1000 square metres (10,764 square feet). That is, the complete installation comprises 92 boilers with a total heating surface of 52,000 to 58,000 square metres (559,728 to 624,312 square feet).

In general the method of firing adopted for the raw lignite is the use of mechanical stokers of the deep trough or step grate type, and it has been proved conclusively, as the result of the most extensive experience, that this design of stoker is much superior for raw lignite than any traveling grate type, confirmed also after disastrous experiences at the working of the Yallourn Power Station on Morwell lignite in Australia. At the same time, however, many of the boilers at Golpa-Zschornewitz are now fitted with auxiliary pulverized fuel firing using pre-dried lignite, and the results obtained are excellent, each boiler being equipped with



One of the 40,000 kw. turbo-generators in the Golpa-Zschornewitz

a complete battery of control instruments on the latest scientific lines.

One of the most formidable problems at Golpa-Zschornewitz has been the handling of the ash and the prevention of dust with such a friable raw material as lignite, and it may be stated that the ash turned out amounts to about 350 metric tons per day, this being handled largely by means of powerful water jet conveyors.

Finally, it may be stated that at Trattendorf and Lauta the operation of the boiler plants is on the same general lines as at Golpa-Zschornewitz, that is, using deep step grates, with mechanical operation of the conveyors and also auxiliary pulverized fuel firing.

For information supplied in connection with the writing of this article, and the photographs of Golpa-Zschornewitz, the author extends sincere thanks to Direktor Dr. E. H. Alfons Peucker of the Elektrowerke A. G. of Berlin.

The Writing *of* Technical Papers

By W. L. DeBaufre
International Combustion Engineering Corporation, New York

Engineers are finding it necessary to write more and more often on the subjects with which they are familiar. Those who have not had the advantage of advanced work in English or Rhetoric are apt to find themselves handicapped when they undertake the preparation of engineering papers or articles. Mr. DeBaufre writes on this topic in a manner that is thoroughly constructive and helpful.

THE object of writing a technical paper is to convey certain information to a group of persons. The authors of technical papers, however, often apparently write with little thought of the persons who are to read the results of their efforts. In writing a technical paper, it is natural for the author to emphasize those parts which he has found difficult and to pass over without mention those parts which have appeared simple to him. The details just mastered will naturally be expanded while the generalizations which make those details intelligible to the reader will ofttimes be omitted, having passed out of mind. After writing a technical paper, it is therefore desirable for the author to go over it with some particular person in mind and modify the paper as may appear necessary to make the subject intelligible to that person. In doing so, the writer should remember that he is handicapped by his own knowledge of the subject, because he can unconsciously supply information that is lacking and will unhesitatingly give the correct interpretation to statements that may be ambiguous to others.

TITLE

First consider the title. Prospective readers ordinarily depend upon the title for deciding whether to read a technical paper. Will the title selected attract the person you want to read the paper? Will he find that the subject under discussion corresponds to the title? A brief title indicating the viewpoint from which the paper is written is generally preferable to a longer title describing more in detail the matters discussed therein. In making a library search for published information along certain lines, clear concise titles are found of great assistance in judging whether technical papers will be of value. A seamen's home bought "The Ancient Mariner" by Coleridge because they wanted to have in their library some descriptions of ancient seafaring life.

INTRODUCTION

After deciding to read a technical paper, the first information desired by the reader is a comprehensive understanding of what the paper covers and its limitations. There should accordingly be an opening paragraph or paragraphs to introduce the subject to the reader and win his interest. Historical information regarding the subject treated and reasons for preparing the paper may be included in the introductory paragraphs; but a long or irrevelant introduction is to be avoided. In a technical article, of course, the introduction need not be startling, as a young author was advised to make the introductions to his novels. He began his next novel with the words, " 'Hell', said the Duchess, as she entered the dining room."

CONCLUSIONS

With the great increase in the mass of technical literature due to the multiplication of scientific and engineering societies and publications, time is not available to read through all technical papers of interest. Definite conclusions in a technical paper therefore extend the usefulness of the paper to those who have not the time to read the whole paper. Some writers give such conclusions immediately following the introduction. It is usual, however, to give conclusions at the end of a paper following the discussions which have led up to the conclusions. To have the value mentioned for the busy reader, the conclusions must convey clear, definite ideas without reading any other part of the technical paper except possibly the introduction.

Such technical papers do not call for conclusions. I used to say to my students that a technical report is not complete without conclusions. Recently, however, I met the boss of one of my former students who had included in a report conclusions reflecting upon the product of a manufacturer to whom the report was to be submitted. I was told that this former student resented omitting the conclusions and submitting the facts only. Thus, even in technical reports, there may be occasions for omitting conclusions.

SUMMARY

A summary of the discussions included in a technical paper is desirable at the end of a long paper in addition to the conclusions, in order that one without time to study the whole paper may readily get some understanding of the basis for the conclusions. It should be possible to read the summary in an understanding manner without referring to the remainder of the paper except the introduction. Certain paragraphs in the body of the paper might be referred to in the summary either as covering more completely the points mentioned in the summary or as containing additional information. No new ma-

terial not found elsewhere in the paper should be introduced in the summary.

BODY OF PAPER

The body of a technical paper between the introductory paragraphs and the summary and conclusions will vary with the character of the subject of the paper. Usually, there will be some description of an article, a construction, an apparatus or a process. However, few technical papers are descriptive only. They generally aim to explain the subject and often offer arguments as a basis for the conclusions derived. To explain and to convince require careful selection of clear concise English to bring the author's thoughts to the reader's mind in a way which will accomplish the desired results.

If the technical paper is written for a publication of limited circulation among a specialized group, the most highly technical language of the subject may be employed with special mathematical and other notation. Usually, however, a technical paper is written for a less specialized group with general technical training only. Some explanation must therefore be usually given of the technical terms employed and the use of only the more generally understood mathematical expressions is permitted. When written for the general public, the simplest language should be used in a paper dealing with a technical subject, and all mathematical terms must be omitted. It is better to use simpler language than necessary rather than employ terms which cannot be understood by most readers.

Irrespective of the language used, the ideas involved should be marshalled in an order which will enable them to be readily grasped by the reader. Failure to do this is one of the most common faults of technical writers. The writer has in mind the full scope of his subject and can appreciate the bearing of each idea as he writes about it. This of course is not true of the reader who sees the technical paper for the first time. He may have great difficulty in following the writer and may find it necessary to read the paper a second time in order to grasp its full significance. A second reading should be unnecessary except for the most intensive study of the subject.

In order to make a second reading unnecessary, the writer of a technical paper should first give a general view of his subject before he goes into details; and for each detail he should make a general statement before he goes into particulars. This does not mean that conclusions should first be given followed by reasons for the conclusions. But the traveler should know something of his destination and he should be able to see part of the road ahead of him.

In building up in the reader's mind the ideas which the author wishes him to acquire, it is essential that the start be made from a firm foundation. If possible, this foundation should be other ideas which the reader already possesses. Then by examples, comparisons and analogies, the new ideas can be demonstrated in a way which will make them truly a part of the reader's mental assets. Statements should be concrete and specific rather than abstract and general.

As a whole, a technical paper should possess unity; that is, the writer should stick to his subject and not ramble off into details which have only the remotest bearing on the subject. The writer should definitely have in mind what the limits of his subject are and then stay within those limits. An effective way to observe unity is to state the limits of the subject at the beginning of the paper. This has the added advantage that it gives the reader an idea of what the limitations are.

The parts of a technical paper should be related to one another in a logical way by a careful division of the subject into its component parts. The sequence of the divisions will depend upon the character of the subject. Thus, a conception of a machine should be built up in the reader's mind by first giving a general idea of its structure and operation followed by detailed descriptions of its various parts arranged in the same order as they exist in the machine. A description of a process might follow the several stages of the process from beginning to end after first giving the reader some understanding of the character and purpose of the process as a whole. Where time is involved, a chronological order may be employed in arranging the contents of a technical paper.

There should also be such a proportion between the several parts of a technical paper that the whole appears in balance without an undue emphasis being placed on one part, or another part being skimped. The writer must be careful to secure this proportion in order that the reader will not get a distorted conception of what the writer wishes to convey to him.

APPENDICES

In the preparation of a technical paper, it may be found that certain information is at hand which should be available to the reader but which would more or less disturb the unity and logical arrangement if included in the body of the technical paper. Such information may very well be made the subject of an appendix to the paper. For example, the mathematical derivation of a new formula used in reaching the conclusions of the paper would be more fitting in an appendix if its inclusion in the body of the paper would give a mathematical color to a subject which does not require much mathematical ability to understand. The adding of an appendix would be better than omitting the derivation entirely, because certain students of the subject would want to check any new formulas included in the paper. Appendices are probably used to a greater extent in technical reports than in technical papers which are usually comparatively short and may therefore be more easily confined to homogeneous material.

REFERENCES

In most technical papers, references will be desirable to other published papers dealing with the same subject or certain phases of it. This not only gives credit where due but enables the reader to carry his study of the subject farther than the paper he is reading, if he so desires. These references may either be put in the form of footnotes or may be listed at the end of the paper. In either case, the references should be numbered or lettered consecutively and referred to in the text by the appropriate numbers or letters in parentheses. For each reference, there should be given the title of the paper, the author's name, the name of the periodical in which it appeared, its date of issue and the numbers of the pages which include the paper. The volume number of the periodical may also be given and may sometimes be substituted for the date of issue.

ILLUSTRATIONS

Technical papers are generally illustrated with tables, curves, drawings and photographs in order to bring before the reader's eyes a graphic representation of the ideas about which he is reading. A well executed drawing or sketch will often convey more information than pages of written explanation. The same care should be used in the selection of illustrations as in the choice of language.

Tables are usually designated by consecutive numbers. Visual devices should be employed to assist the reader to read corresponding numbers in the tables, such as vertical or horizontal lines or spaces extending through the mass of figures.

The reproductions of curves, drawings and photographs are generally called "figures" and are numbered consecutively throughout the paper. It is customary to list all the figures included in a patent application, in a paragraph immediately following the opening statement regarding the general objects of the invention; but this is not the preferred way for technical papers. In patent applications, this custom helps the patent office in checking the number of drawings filed with the application. In the usual technical paper, such a procedure would thrust all the illustrations upon the reader before he is prepared to profit by their examination. It is therefore preferable to mention each figure at the point in the paper where the discussion pertains to it. The figure itself may then be inserted at about the point where it is mentioned. The reader can read about the figure and see it without turning a page. A concise descriptive caption is desirable for each figure.

As the figures in a technical paper are limited by the size of page of the periodical in which the paper is to be printed, much detail cannot be shown. Working drawings must generally be redrawn to omit considerable detail, and only a few dimensions can be included. Curves must usually be replotted with cross-rulings wide apart, and are generally illustrative rather than useful for computations.

In securing a photograph for a technical paper, it is often desirable to take the photograph in such a way that the reader of the paper will get some idea of the size of the object photographed. A man in the picture often accomplishes this result. This is sometimes overdone, as by the valve manufacturer who always picked the smallest man in the shop to photograph with the largest valves while the biggest man in the shop was selected to hold the smallest valves.

Outline of Technical Paper

TITLE

Clear and concise statement of subject preferably indicating viewpoint from which paper is written.

INTRODUCTION

Brief history of subject, or
Reasons for preparing paper and
Limitations of subject.

BODY OF PAPER

Possess unity as a whole.
Parts arranged logically.
Various parts in proportion.
Made up of main divisions, subdivisions and paragraphs.

SUMMARY

Summarizing discussions in body of paper without introducing new material.

CONCLUSIONS

Clear definite statements which can be understood without reading body of paper.

APPENDICES

Containing material supplementary to but not desirable in body of paper.

REFERENCES

Title of paper,
Author's name,
Name of periodical,
Date of issue or
Volume number and
Page numbers.

PARAGRAPHS

The aim of paragraphing is to make a technical paper easier to read both from the standpoint of following the type with the eye and of perceiving the divisions of the subject. The reader should be led through description, exposition and argument in gentle stages by dividing the subject into divisions each dealing with a particular phase of the subject. In passing from one paragraph dealing with a certain phase of the subject to another paragraph dealing with a different phase, the change in thought should be accomplished by means of a transition sentence either at the end of one paragraph or at the beginning of the next.

Paragraphs should not be too long as this makes the reading matter hard to follow. Neither should the paragraphs consist of single sentences. Usually, however, there are reasons for paragraphing other than the number of words included in a single paragraph.

When it is desired to offer a number of definite recommendations, each may be made the subject of

a separate paragraph. In doing so, care should be taken not to give equal weight to major and minor recommendations, which separate paragraphs tend to do. Arranging the recommendations in the order of their importance and care in the wording of the different recommendations will secure the desired emphasis.

In general, each paragraph should deal with a certain central thought about which details are given to show its meaning and application. The central thought should preferably be stated at the beginning of the paragraph in either the first or second sentences. This informs the reader immediately as to the phase of the subject he is about to take up. It may then be desirable for added clearness to define or limit the subject of the paragraph before going into the details which develop the central thought.

The order of these details must be determined for each individual paragraph according to the subject matter. In a paragraph dealing with one part of a machine, the detailed description may give the relation of this part to the other parts of the machine, its mechanical construction, its appearance, etc. In a paragraph dealing with one step in a process, the relation of this step to the entire process may be described as well as the several operations which make up this step. In a paragraph dealing with more abstract ideas, the central thought must be developed by defining the terms used, referring to and comparing with well known facts, giving examples and illustrations, etc. It may be desirable to restate the idea developed in some emphatic form as a conclusion to the paragraph.

Sometimes the central thought of a paragraph cannot be definitely stated at the beginning of the paragraph due to its being unintelligible to the reader without considerable development of ideas which the paragraph is intended to accomplish. Some introductory remarks are then required to start the reader thinking along the lines desired and the statement of the central thought comes as a conclusion to the paragraph.

SENTENCES

A well-formed paragraph results from careful attention to the form and arrangement of the individual sentences which make up the paragraph. Each sentence should do its part in developing the central thought of the paragraph. Details of equal weight should be shown by similar sentence construction, while major and minor details should be indicated by the use of different sentence constructions. Sentences should be bound together by various transition devices such as a phrase at the beginning of a sentence in which the idea of the preceding sentence is picked up and carried on, or a word may be used indicating that the sentence is related in some manner to the preceding sentence. The words first, second, next, afterward and then indicate sequence of ideas; the words also, moreover, again and furthermore indicate addition of ideas; the words however, yet, nevertheless and in spite of indicate contrast of ideas; the words therefore, consequently and accordingly indicate a result.

It is only by practice that perfection is attained in the writing of clear, logical sentences which say exactly what the writer meant to say. It should not only be possible for the reader to give the correct meaning to the combination of words used in a sentence, but he should find it impossible to give the sentence any other meaning. Bad sentences often result from the attempt to obtain conciseness by the omission of necessary words and phrases. All sentences should be grammatically correct. Good sentences are obtained by stressing the important ideas and making the unimportant ideas inconspicuous.

Each sentence should be a unit and not contain ideas which have no relationship to one another. Long, rambling sentences are to be avoided. On the other hand, sentences should not be so short as to be "choppy". When closely associated ideas are included in the same sentence, the principal thought should be expressed in the principal clause and subordinate thoughts given in subordinate clauses or phrases in such a way as to indicate their relations to the principal thought. Subordinate ideas of equal weight should have that fact shown by similarity of structure of the different phrases or clauses which embody them. Care should be taken in using modifying phrases or clauses to place them so that the word modified will be clearly indicated. Unless the proper form of modifying phrase or clause is used, absurd results may be obtained. Care should also be taken to have the antecedent of every pronoun clearly indicated.

WORDS

Little can be said regarding the selection of words to express a given idea in a technical paper except that the simplest word should in general be used. In engineering and scientific work, words often have a meaning different from or more precise than that given to them in general speech. It may occasionally be necessary to define certain words used in technical articles to insure that the reader will fully understand the subject under discussion. Except for emphasis, avoid the too frequent repetition of the same word.

Correct spelling of words is simply a question of habit. Everyone should develop the habit of spelling with reasonable correctness. Such a habit may be mainly dependent upon the eye or upon the ear or upon the throat or even upon the hand, depending upon the personal characteristics of the individual. While most of us utilize all these organs in determining whether a word is correctly spelled, the eye probably tells us most often whether a word looks right or wrong. For the correct spelling of certain technical words and the use of the hyphen, the

reader is referred to the Style Manual for Engineering Authors and Editors published by the American Society of Mechanical Engineers.

ABBREVIATIONS

Most engineers are apparently ignorant of the fact that certain standard abbreviations for units and other technical terms have been in use for 25 years by the larger engineering societies of the United States. This ignorance is indicated by writing "10 lbs." instead of "10 lb." and "Fahr." instead of "fahr." For abbreviations of mechanical engineering terms, the reader is referred to the Style Manual published by the American Society of Mechanical Engineers. A long list of permissible abbreviations is given therein. If every engineering teacher would make himself familiar with this list and require his students to follow it, he would be doing them a service. It is just as easy to learn to abbreviate rightly as wrongly.

SYMBOLS

In most technical articles, it is desirable to use symbols as a means of showing relations between different quantities involved in mathematical formulas. Symbols should not be used to take the place of good English words or accepted abbreviations. The symbol "#" for pound or for number has no justification, as it is ambiguous and "lb." or "No." can be written just as easily as this symbol.

Technical writers often make their papers difficult to read by referring to symbols without indicating their meaning. It is not sufficient to define the symbol at some one point in the paper, as the reader will have difficulty in locating this point when he comes across the symbol. Some writers give near the first part of each paper a list of all symbols used with definitions and units, so printed as to stand out from the other printed matter of the paper. This is of material aid in locating the meaning of any particular symbol; but even in this case, the writer should include some descriptive word or words when mentioning a symbol, such as, the rate of heat transfer k, the total heat g, instead of simply mentioning k or g.

The American Standards Association has approved certain Standard Mathematical Symbols, while Symbols for Heat and Thermodynamics, for Hydraulics, for Aeronautics, etc., are proposed as Tentative Standards. Whenever possible, symbols should be selected in conformity with these standards.

CAPITALS

"As a general rule, avoid the use of capitals where possible." This is the first rule under "Capitalization" in the Style Manual previously mentioned. Other rules follow in the Manual telling when to use capitals. For notes on drawings and for descriptions and units of coordinates of curves, it is well to capitalize the first letter of the first word only unless a proper name appears in the note or description or unit.

ITALICS

"Use italics sparingly as they detract from the appearance of a printed page and lose their effectiveness if appearing too often." This is the first rule under the above heading in the Style Manual mentioned.

PUNCTUATION

The Style Manual mentioned contains a number of rules regarding punctuation, and the reader is referred to this Manual for the information therein. The more straight forward the English, the less will be the trouble in properly punctuating. This statement is not intended to indicate that punctuation is of little importance as expressed by the visiting President of the School Board to little Johnny who did not get his commas in the right place. The teacher thereupon asked Johnny to write on the blackboard, "The President said the teacher is a fool." Johnny was then told to put commas after President and after teacher. Proper punctuation in a technical paper assists the reader in understanding it.

BOOKS ON SUBJECT

In writing this paper, very few illustrations have been included to drive home the general statements made. The reader can find such illustrations in the following books in addition to the Style Manual of The American Society of Mechanical Engineers already mentioned several times.

The "Composition of Technical Papers" written by Prof. H. A. Watt and published by McGraw-Hill Book Company, is a well written book on the subject.

A "Handbook of English for Engineers" written by Prof. W. C. Sypherd and published by Scott, Fresman and Company, not only contains many quotations from technical writings but also gives a bibliography on the subject.

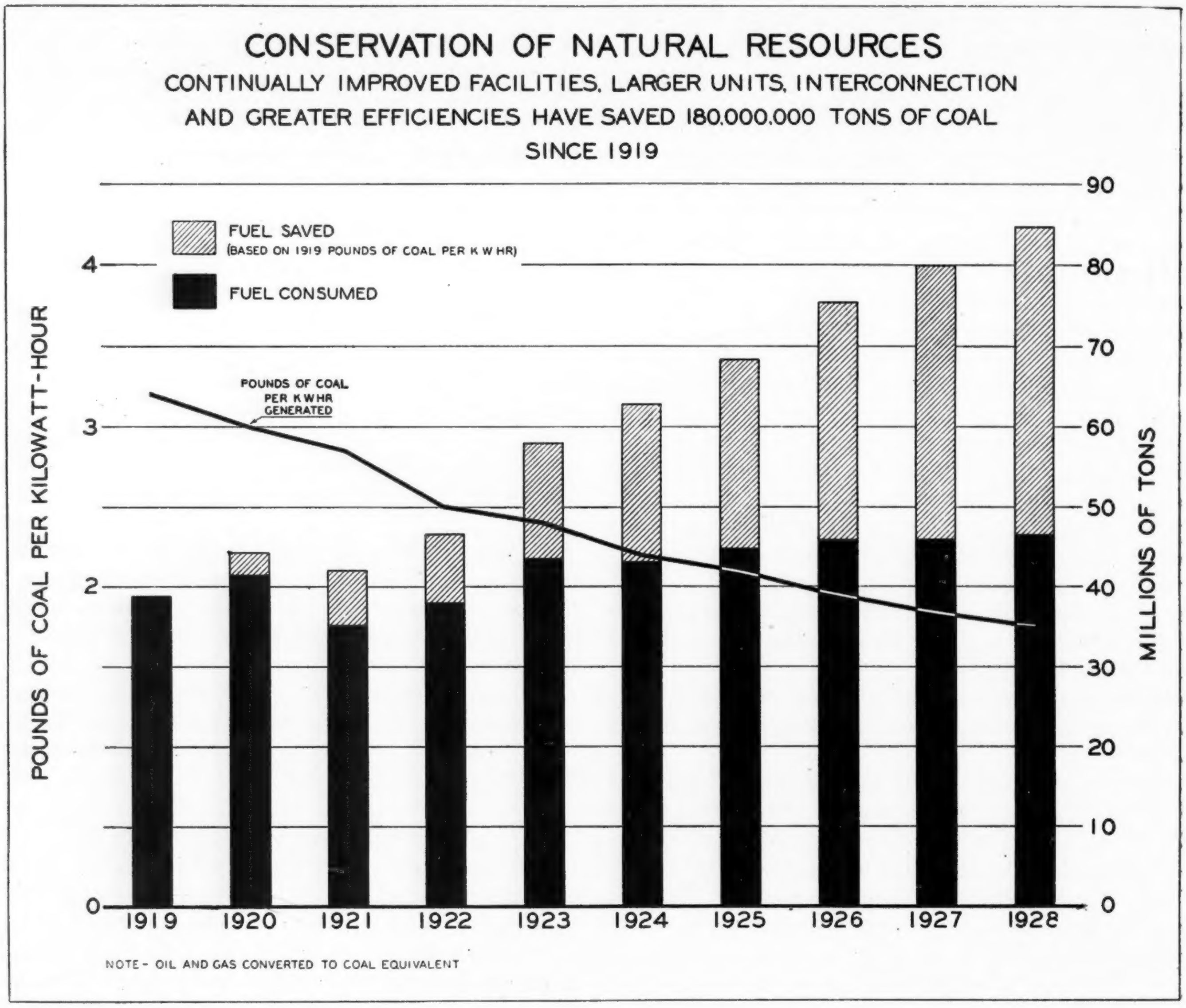
The newspaper man's view of writing to interest the reader will be found in "Handbook for Newspaper Workers" by Prof. G. M. Hyde, published by D. Appleton and Company.

PREPARATION OF MATERIAL

The subject of a technical paper is usually either assigned to the writer or suggested by some of his personal experiences. No technical paper should be written simply to get the author's name in print. After the decision has been reached to write about a given subject, time is spent in gathering additional information and in studying over that which is already in hand. The subject as a whole should be turned over and over in the author's mind until some definite viewpoint appears which will enable him to present the information to the reader in a logical, consistent manner.

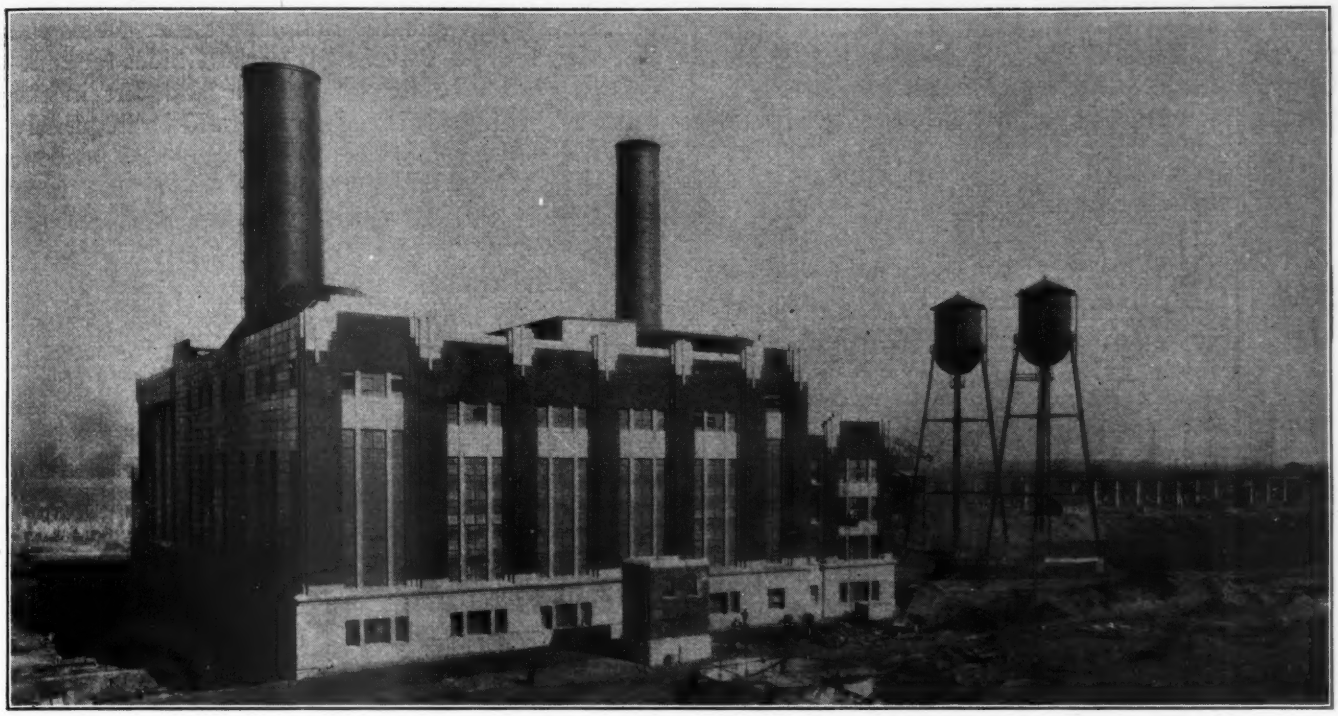
If the writer is very well versed in his subject, he may begin to write as soon as this definite viewpoint appears without preparing a written outline, particularly if the paper is to be a short one. In order to prepare a technical paper of merit, however, it is generally necessary to classify the material available by preparing a written outline of the paper. This outline will include the introduction, the conclusions, possibly a summary, and the body of the paper between the introduction and the summary and conclusions divided into sections. Under each main division of the subject may be subdivisions and these in turn may be divided into paragraphs. It has been suggested that such an outline be prepared on cards, using one color for the main divisions, another color for the subdivisions and a third color for the paragraphs. The cards may be shuffled until the best arrangement of the material is obtained.

In utilizing the outline to write the paper, the author should, as far as possible, keep in mind the mental qualifications of the probable readers and consider how each thought as it is expressed will penetrate the reader's consciousness. Has the reader's mind been prepared to receive the new idea? If the soil has been properly prepared, the seed planted should take root and grow into the form pictured in the creator's mind.



Since 1919 no less than 180 million tons of coal have been saved. Ten years ago, nearly 3¼ pounds were required to generate a kilowatt hour of electrical energy. By 1922 this had dropped to 2½ pounds and in 1928 there was a still further decrease to 1¾ pounds.

The constantly increasing efficiencies of steam generating plants located at or available markets for power are making them serious competitors of hydro-electric enterprises particularly when the location of the water power is such as to require heavy investments in long distance transmission lines.



Twin Branch station of American Gas & Electric Co., Mishawaka, Ind.

Placing a Steam Power Plant *in* Commission

By William S. Johnston

Mechanical Engineer, Stevens & Wood, Inc., New York

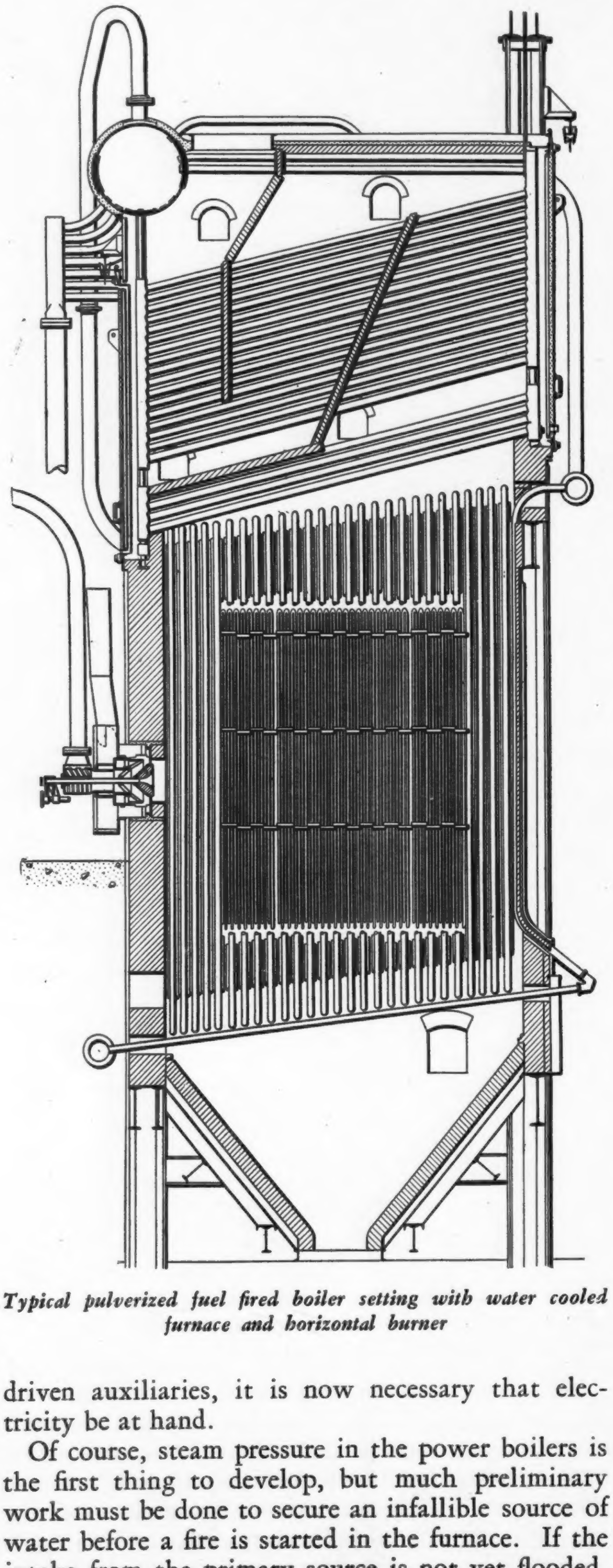
INITIAL starting of a steam electric plant on its useful career of commercial service is a serious undertaking involving thoughtful and careful consideration requiring wide experience and mature judgment. It is a responsibility which should be assumed only by seasoned operating engineers. This fact is recognized in the majority of industrial plants and public utilities. The engineering laity in general is being educated to appreciate it by the speed limitations imposed on new automobiles by their manufacturers.

Each new plant about to be commissioned is different than any other existing plant, because the art of central station design is in a period of transition featuring extraordinary efforts to obtain the last iota of thermal efficiency. Hence, irrespective of the breadth of the engineer's experience, it is essential that upon undertaking to start up a new plant he familiarize himself with the general station heat cycle as established by the designers and the flow diagrams of the different media. With these as a basis he may then learn the locations of pipe lines and their valves as installed in the plant. This preliminary study is essential and should be followed until the engineer has made his knowledge of the system really a part of himself and it becomes second nature to know the exact location of necessary valves. This is of immense value in operating a plant and particularly invaluable in case of an emergency, either day or night, in starting new and untried equipment.

A steam electric power plant operating under load is a masterpiece of mechanical coordination. Although carefully designed and painstakingly built for just that operation, the starting up period invariably develops a crop of minor troubles. Mr. Johnston, in describing the actual starting up of such a plant, easily proves his own statement that only seasoned operating engineers should attempt this highly complex undertaking. The plant selected is fired with pulverized coal, and has centrifugal feed pumps, induced draft fans, and the other usual equipment of a modern central station.

Till within recent years a steam plant was started with steam. The construction forces had one or more boilers, sometimes stationary, more often portable, that supplied steam to a plunger type pump feeding raw river water to the larger boilers. Coal was fired by hand, or on a stoker driven by a small steam engine. Furnace draft was developed by a tall chimney, or a steam driven fan. Today a steam plant is started by electricity, which is such a common commodity, and its distribution so widespread, that even in the most isolated localities it is only necessary to build a temporary line for a few miles to make current available for oper

ating the construction equipment. Sometimes power may be fed back over a transmission line to small temporary step down transformers for starting purposes. But with the gradual adoption of all motor



Typical pulverized fuel fired boiler setting with water cooled furnace and horizontal burner

driven auxiliaries, it is now necessary that electricity be at hand.

Of course, steam pressure in the power boilers is the first thing to develop, but much preliminary work must be done to secure an infallible source of water before a fire is started in the furnace. If the intake from the primary source is not yet flooded, it is desirable that the starting engineer should make a personal examination, to ascertain that no construction debris remains that may either block the tunnel or foul the traveling screens. Guides for shut-off gates must be free of concrete and dirt in the grooves. The gates themselves should be frequently operated, whether by hand or power, and not put into commission until their full travel has been definitely established and limit switches set if motor driven.

Unless only stationary rack bars are used at the mouth of the intake, power operated rack cleaners must be given a trial. With these precautions taken, the traveling water screens should be examined and, if the baskets and chains are all clear, they may be turned over. They are usually motor propelled thru reduction gears. The bearings must all be oiled or greased, as the case may be, after being flushed out with similar oil or grease, never gasoline nor kerosene. The reduction gear case must be filled with oil as recommended by the gear manufacturer and to the level specified. Then the motor switch may be closed, the direction of rotation noted during a moment's operation, and the switch quickly opened. If the rotation is correct, the switch may again be closed for a few minutes and then opened. The operations should be repeated until the screen has made successfully one complete revolution and then it may be left running for several hours under the supervision of an operator who periodically observes the temperature of all the bearings and the gear case.

In case the direction of rotation of any piece of equipment is found to be reversed upon starting it must be immediately shut down. If the driver is a motor, the trouble can be corrected by interchanging the supply wires on the motor terminals. If the trouble is with steam driven apparatus it is necessary to check the assembly of the driver and driven units and, if not correct, relocate the driver on the other side of the driven unit.

The procedure so far has brought water to the suction of the raw or service water pumps and it is now in order to start the first of the equipment within the plant proper. The engineer should satisfy himself that the pumps with their drivers have been properly set and anchored into place by grouting. If he has any fears as to the mechanical condition of the pump interior he is warranted in lifting the casing and examining it. Very often a block of wood, rags, overalls or a wrench have been stuck into either the suction or discharge nozzles during construction. In any event, he should be certain the impeller is free to turn by hand and does not bind. All the bearings should be cleaned out, filled with the proper oil and the oil rings turned around by hand.

The water piping system served by these pumps should next be examined for open connections and ends. All sectionalizing valves and those controlling branches should be closed. Being certain the system is in satisfactory condition and ready to withstand pressure, the pumps, one at a time, may then be

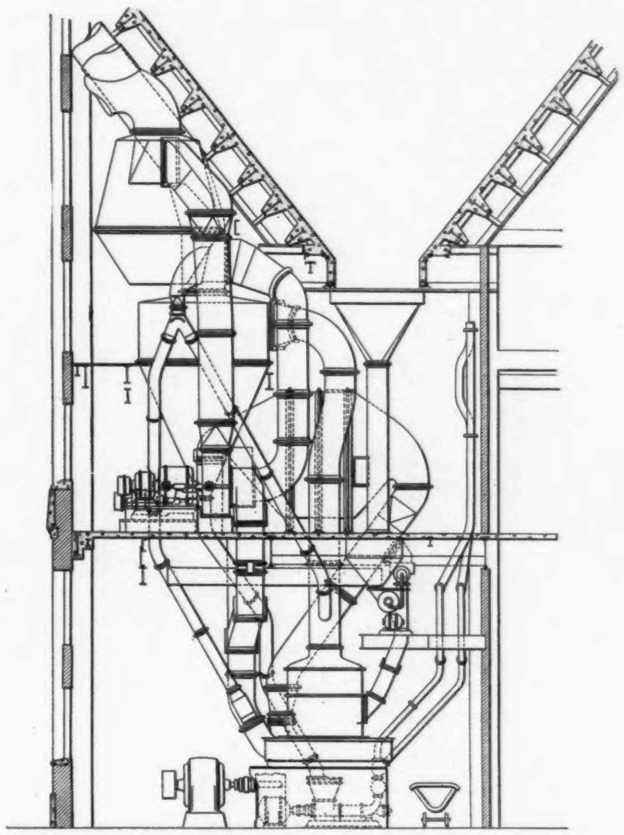
primed, preferably by water from the construction plant. No pump should be started until one is certain the pump casing is full of water, otherwise it may overheat where clearances are close and the impeller will seize on the wearing rings. When fully primed the pump may be turned over once or twice by power from the driver and the rotation checked. When it is established that this is correct, the pump may be started and pressure developed on the entire system by successively opening valves.

At this time it is well to have several construction pipe fitters at hand to take up leaky joints for there are always some leaks. If pressure does not build up on a line it may be due to a blind gasket inadvertently slipped in, or a disc may have come off a valve stem. Sometimes it may be due to an obstruction of foreign material in the line. But when the line is all clear then an end should be opened for a free discharge of the water handled by the pumps, throwing it overboard to waste. This permits operating the pumps under partial load, obviates overheating the pumps by churning the same water and allows the bearings and other contact surfaces to wear into a smooth finish. Of course, all bearings should be watched for overheating and the oil rings frequently observed as sometimes they stick and do not lubricate the journals.

Starting these pumps has been detailed at some length to outline certain fundamental principles in starting all centrifugal equipment. In a few words the adage holds true, "Be sure you are right and then go ahead." All rotating equipment when it is initially started should be operated under but a light load for at least several hours, if not an entire day. If it is steam driven it is desirable to run at about hal speed or less. In the case of constant speed motor drives this is impossible. But gently breaking in wearing surfaces gives them a polish that makes for long life free from troubles in the future.

Most plants are laid out so that in an emergency raw water may be supplied directly to the boiler feed pumps under pressure from the service pumps and may by-pass the make-up water treating apparatus, evaporators, deaerators and feed water heaters. This connection may be used now to feed the boilers. The boilers presumably have been already filled with water from the construction plant for safe use with the drying out fire that has seasoned any refractory used in the furnace and boiler settings. If this water is known to carry much mud and sediment the boiler and other pressure parts should be drained, after extinguishing the fire in the furnace, and any mud washed down with a hose introduced through the drums and headers. The boilers may now be closed and refilled by the regular feed pumps receiving water from the service system. The starting of these pumps one at a time should be along the lines previously established, except they need not be primed, as the water is delivered to their suctions under pressure. Of course, it is essential that the feed water system be brought under pressure gradually, all valves checked and leaks stopped. Feed water regulators must be carefully observed to be certain they function correctly, their connections are not interchanged and the regulating valve is free to follow the impulse on its stem and not constrained by a tight packing gland.

While a reliable source of water has been established, doubtless in the meantime another crew of operators has been making the fuel available. The construction forces have probably tried out the coal unloading equipment and operated the conveyors and elevators so that a supply of crushed coal is on hand in the bunkers. However, the operators should check the performance of the coal system to their own satisfaction, especially the capacity of it. Coal may now be fed from the bunkers to the mills, successively passing over the magnetic separators, the coal scales and the mill feeders at a rate to supply only the minimum coal required by the mills.



Arrangement of preparation plant for pulverized fuel

The magnetic separators and feeders with their drivers may be turned over idly before being loaded so as to be certain they are mechanically correct. The scales must be loaded to function. The construction forces should have tested them for accuracy, but if not then the operators must do so.

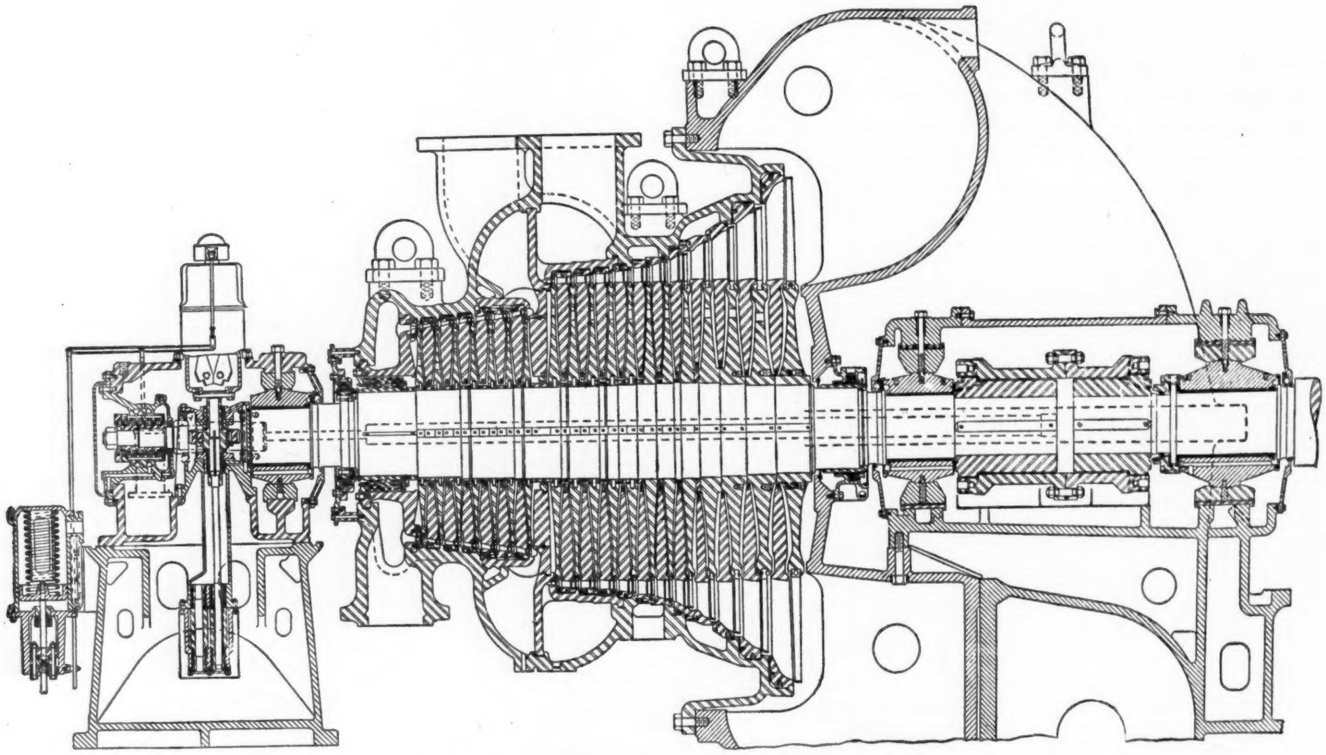
The pulverizing mills require great care in starting. Most types cannot be run empty to break them in as excessive wear will occur between the grinding parts. However, as mills are generally motor driven,

they may be turned over empty to check rotation and the automatic lubricating system. They should be carefully examined as to mechanical condition both externally and internally and it would be well for the operators to note the condition of the grinding surfaces and caliper them to determine the amount of wear at some time in the future.

With coal available at the mills, it is now permissible to start the draft equipment. In the larger plants this is usually mechanical, consisting of induced and forced draft fans, usually motor driven, sometimes steam driven by turbines. The induced draft fan supplies the suction to furnish the furnace draft and overcome the draft losses through the boiler, superheater, economizer, if there is one, and the air preheater. The forced draft fan furnishes under positive pressure the primary and secondary air for combustion and its effect stops just inside of the furnace wall wherein are set the burners.

In starting both fans their housings should be given a careful internal inspection to ascertain that no construction material fouls or will foul the impellers. The entire rotating element of fan and driver must turn over freely by hand before power is applied to determine if the shafts are held too tightly by the bearings. The latter must be carefully cleaned out by flushing with lubricating oil and then filled with oil of the proper grade. Generally the fan bearings are water cooled from the service water system, and this feature must be examined to determine that no water inadvertently leaks into the oil pockets With these precautions taken the fans may be revolved by power to check direction of rotation during a turn or two. If found correct, or if corrected, they may now be operated handling only air. Except in the case where a single speed motor is the driver this may preferably be at about half speed for several hours, or a day, to wear in the bearings during which time the oil rings must be watched and the temperature of the bearings noted.

This method of starting the draft equipment affords time to go over the gas and air duct system and stop leaks at the joints and open holes where bolts have been omitted. The air preheater can be given a preliminary check also.



Steam turbo generator of type referred to in this paper

If motor drivers are used for both the pulverizing and draft equipment they are electrically interlocked. The operating electrician should carefully check the wiring diagram and the actual installation against the diagram. The interlock feature is a safety device. By its means the system is shut down up to the point of failure. If a mill motor trips out, the coal supply to it stops. If the induced draft fan fails, the coal to the burners is shut off.

The mill exhausters are to be started next, in the manner of bringing any fan into commission. The distributors, coal pipes and burners should be carefully examined. If everything is found satisfactory the engineer may now light off one or more burners, depending on the number receiving coal from a mill

unit When lighting burners the induced draft fan must always be in operation, as provided by the interlock, and they must be lighted quickly to avoid an accumulation of pulverized coal in the furnace. Steam pressure may now be developed on the boiler, allowing a day or so to come up to the working point.

The steam piping system may be brought into commission, meanwhile watching the behavior of the valves and for leaks at joints, cast steel fittings and valve bodies and stuffing boxes. While being warmed, the condensed steam must be drained off and not permitted to accumulate to rot fibre gaskets and cause water hammer. As soon as convenient, the lines to the turbines should be blown out at full boiler pressure to remove pipe scale and any foreign material left in during construction.

Moving over to the turbine hall, the engineer may prepare to start the main generating equipment. Probably the first item to receive attention is the spare exciter driven either by a motor or a turbine. The generator end may have to be dried out on a short circuit. With this unit available any other generator may be put on a short circuit for drying. If an auxiliary or house unit has been installed it may now be put into commission. Generally the turbine of such a unit is non-condensing and its exhaust steam must be absorbed by the feed water system, probably in the deaerator, so that this piece of equipment is also placed in service.

The circulating water pumps of the main units may now be started in a manner similar to the service pumps as usual when water is available for the latter, it is also for the former, both having their suctions in the same well chambers. If a pump will not prime, or loses its suction, then look for air leaks in pipe joints, packing glands of valves, porous cast iron pipe and that the ends of the suction lines are sealed with water. With water flowing through the condenser, the main unit turbine may now be rolled over upon oil pressure developed by the auxiliary oil pump, usually steam turbine driven. The spindle or rotating element and the casing must be warmed slowly by revolving the spindle as soon as the throttle valve is opened. An attempt to warm a stationary spindle results in warping it with consequently blade rubbing when turned over. Steam should be turned on the glands and vacuum raised on the condenser, say 15 or 18 inches of mercury. From now until the machines are brought to full speed some days hence they should be carefully watched, noting the oil pressure and temperature, the amount of expansion on the governor end and listening to the casing, glands and thrust bearing by means of a stethoscope for any unusual sounds caused by rubbing. When brought to full speed all machines should be overspeeded and the overspeed safety stop setting checked. This device is generally set at 10 per cent above the normal speed. This safeguards the spindle against stresses exceeding about 20 per cent those due to running at the design point.

Before drying the main generators, the entire electrical layout of the plant must be carefully checked by the operating electrician and his chief. Circuit breakers are to be tripped, relay settings back checked and, if necessary, the switching wiring and that to the current and potential transformers. Main and auxiliary power busses should be investigated for broken insulator supports, location of switches and connections to generators.

Most generators now require less time for drying than they did some few years ago. Two or three days are sufficient to obtain check readings on a megger. They may or may not be identical with those reported by the factory. With one or more generators dry, potential may be gradually raised on the lines to the step-up transformers. If all is well, partial load may be placed on one machine at a time and gradually increased to full load. The station is now in commercial service and the first of next month the main office begins collecting a return on the investment.

Coal in 1806

THE discovery of "black stone" in abundance at Plymouth, Pa., in 1806, aroused the curiosity of a small town blacksmith named Abijah Smith, who decided to investigate that area. Leaving his forge, Smith made his way to Plymouth.

It is not known whether Smith placed the coal in his landlord's fireplace by accident or not, but after finding that it burned and provided great warmth he was convinced of its efficacy as a fuel. It was not a simple matter to convince others of his discovery. It is said that he invited the leading citizens of the near-by towns to witness a demonstration of the newly discovered fuel. He was given permission to use his landlord's fireplace for the demonstration.

The appointed day arrived and the inn where Smith stayed was filled with curiosity seekers. To Smith's great dismay the coal did not catch fire. The irate spectators were about to berate Smith for his folly, but he curbed their annoyance by inviting them to dinner in another room. After dinner, when he and his guests returned to the room where the demonstration was held, the coals had caught fire and were burning brightly. The news spread far and wide, Smith receiving orders from all over the State for shipments of this unique stone.

With the aid of his brother John, Smith set out to mine the coal. A barge called the Ark was constructed to deliver the coal to distant points. New York received its first shipment of coal in 1808.

From a mere curiosity this "black stone" has come to be the backbone of our modern civilization. It warms our homes, lights our nights, and literally turns the wheels of progress all over the world.

Correct Boiler Design *an* Essential Factor *in the* Production *of* Dry Steam

By K. Toensfeldt

Combustion Engineering Corporation, New York

One of the problems incident to the recent remarkable growth in sizes and capacities of steam generating units, is the production of dry steam. In this article Mr. Toensfeldt discusses the importance of the circulating elements of a steam boiler; and the limitations encountered in the direction of large diameter drums. The subject is of vital importance, and the treatment is clear and instructive.

THE trend of design of modern steam generating units is toward larger capacities and higher ratings, along with higher steam temperatures and working pressures. Units have increased in size to a maximum capacity, at the present writing, of nearly a million pounds of steam per hour. Pressures have risen from about two hundred pounds per square inch, to as high as eighteen hundred, with thirty-two hundred pounds mentioned as a possibility, although the usual pressure range is from four hundred to four hundred and fifty pounds.

To increase boiler heating surface, tube lengths have been increased. In the case of bent tube boilers, drum centers have been increased from eighteen or twenty feet, to as high as twenty-seven or twenty-nine feet; and in straight tube boilers, tube length has been increased to twenty-four feet, and the number of rows high in some cases is as great as twenty-four.

A further increase in heating surface has been accomplished by the addition of water-cooled walls, which, because of their effective absorption of radiant heat, do from thirty to fifty per cent of the total work done by the unit in which they are located. Moreover, their use has permitted greater combustion rates and higher furnace temperatures, thus further increasing the absorption by the boiler proper.

With increasing steam pressures, drum cost has become an important item; and since the shell thickness increases directly as the pressure and drum diameter, with high pressures it becomes desirable to keep the diameter as small as possible. If insistence on too small a drum is made, however, the danger of excessive moisture in the steam leaving the boiler is encountered. Moisture in the steam in large quantities may cause injury to the superheaters by the deposit of suspended solids from impure boiler waters, and will certainly cause fluctuations in the superheat. Water may even be carried to the turbine, and in such cases expensive outages of the prime mover may result. The criterion of the most economical design is then, the minimum drum capacity consistent with the production of dry steam. Not that sufficient drum capacity is the only factor, or even the most important factor in the production of dry steam; but the desire is to arrange the other factors, by good design and careful operation, so that the maximum satisfactory steaming capacity of a given size of drum may be realized. A study of the influences causing wet steam is therefore timely, so that the purchaser as well as the builder of boilers may know the factors involved which will aid as a guide in boiler selection.

Influences within a boiler that may cause wet steam, considering only the internal drum baffling usually furnished by most boiler builders, are as follows:

(a) Insufficient steam space, when considered in connection with:
1. Constant load
2. Variable load
3. Non-foaming water
4. Foaming water

(b) Insufficient water surface for:
1. Steam release
2. Water draw down (reserve storage)
3. System of feed water control

(c) Improper circulation due to:
1. Restricted interdrum circulators
2. Improper water wall connections

The influences listed under (a) may be readily understood. The steam space is a measure of the time involved for permitting the moisture to settle out of the steam; the lower the ratio of cubic feet of steam to cubic foot of steam space, the lower proportionately may be the settling velocity of the moisture particles from the steam. The cubic feet of steam per cubic foot of steam space may then be considered a direct measure of the settling velocity of the moisture particles from the steam, other things being equal.

However, the amount of steam space will vary under different operating conditions. Improper feedwater regulation under sudden load fluctuations may cause an abnormal rise in the water level, thereby reducing the available steam space and increasing the entrained moisture in the steam leaving the boiler. An unsuitable feedwater treatment, or the lack of any treatment, or too high a concentration

of dissolved solids due to insufficient blow-down, may result in a foaming water, which reduces the effectiveness of the steam space and consequently increases the moisture.

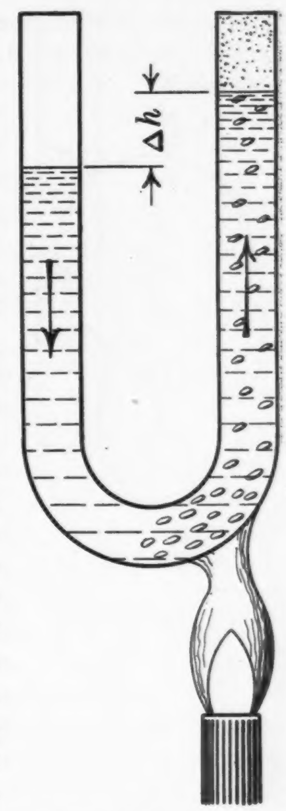
The influences listed under (b) are chiefly realized under variable load conditions. As indicated in the preceding paragraph, fluctuating loads cause temporary increases in steam release per square foot of water surface with rising water level and simultaneously decreasing steam space. The greater the water surface, the less will be the amplitude of these fluctuations, since the water surface is practically a direct measure of the reserve water storage capacity for meeting fluctuating loads. Fluctuating loads may be produced by a sudden steam demand or by a sudden change in the fuel feed. Sudden brief interruptions in fuel flow cause a collapse of the rate of steam generation within the tubes, accompanied by a drop in the water level, and then, upon resumption of fuel feed, a sudden return in steam generation up to full capacity, resulting in a rise in the water level. Should the water storage capacity be insufficient to meet such fluctuations, the water level may rise to the top of the steam space and cause objectionable priming. A foaming water would of course add to the degree of priming under such conditions.

In these cases of sudden load fluctuations an improper system of feed water control may help to produce an undesirable fluctuation of water level. The interruption of fuel feed stops steam generation within the tubes, causing a substantial drop in water level. Then the feedwater regulator adds water in an attempt to maintain the normal water level. When the fuel feed is again resumed, steam production is also resumed, and the water level rises. The regulator then shuts off the feed. This interruption of the flow of feedwater now causes the heat, which otherwise passes into sensible heat required to raise the feedwater to saturation temperature and consequently forms no steam, to be used in making additional steam out of the water at steam temperature within the boiler. The result is that due to the presence of relatively more steam bubbles within the tubes, the entire mass expands still further and the water level in the drums rises beyond the desired limits.

In such a case it would be desirable to have a system of feedwater regulation that would regulate by the weight of water within a boiler as well as by the level of the water within the drums, so that by the proper cooperation of the two means of regulation the possible extreme fluctuations referred to above would be minimized or entirely eliminated. That part of the regulator which responded to the weight of the water in the boiler would not feed when steaming ceased but would resume feeding when steaming was resumed. The action of such a regulator, or that part of it which responds to the weight of the water in the boiler, would be just the opposite of that of the usual regulator in that it would retard the flow of feed water during a sudden drop of water level and would accelerate the flow during a sudden rise of the water level.

Circulation within the boiler, its circulators, and interconnected water walls, has an important influence on the separation of water from the steam, as listed under (c), when, due to improper design, the desired water levels are not maintained.

Boilers, whether of the bent-tube or straight-tube header type, may be considered as the equivalent of large U-tubes, in one leg of which there is a mixture of relatively low density, while the other leg is full of a mixture of relatively high density. Circulation is produced by the steam bubbles rising in the low density leg due to their buoyancy, and by water from the high density leg flowing into the vacated space.



Normal difference in water levels △ h due to difference in densities.

All the steam discharged by the rising leg must find its way through steam circulators to the steam off-take drum, and the resistance encountered in the circulators will demand a higher pressure in the drum or headers at the top of the rising leg than in the steam off-take drum. As the amount of moisture present in the steam passing through the circulators increases, this pressure drop through the circulators rises rapidly and has the effect of offsetting the tendency of a higher water level in the rising leg than in the dropping leg, the dropping leg terminating in its upper end in the steam off-take drum. The rapid rise in pressure drop through the steam circulators is due to the acceleration of the increasing quantities of water up to the velocity of the mixture through the circulators. With very high ratings this pressure drop may be so great that the water level in the drum or headers on the rising leg will be driven down considerably below that in the off-take drum, so that in case the water level is maintained by a gauge or feed water regulator in the off-take drum, the water level in the rising leg may become dangerously low; or if the water level is maintained in the drum above the rising leg, the level in the off-take drum may become undesirably high.

There likewise may be restrictions in the water circulators between the steam and water drums of bent tube boilers which would similarly influence the relative water levels in the two drums. Investigations have shown that the entire circulation within

the tube banks may be altered by a variation in the resistance to flow through these water circulators. It would not be impossible to provide three steam and water drums for a high rating boiler and with improper circulator design, have but the capacity of one drum available for moisture separation from the steam, due to the differences in water levels that would result.

If water walls be placed in the furnace and connected into the drums of boilers, then not only must the capacity of the drums be increased but also in the case of bent tube, multi-drum boilers, the capacity

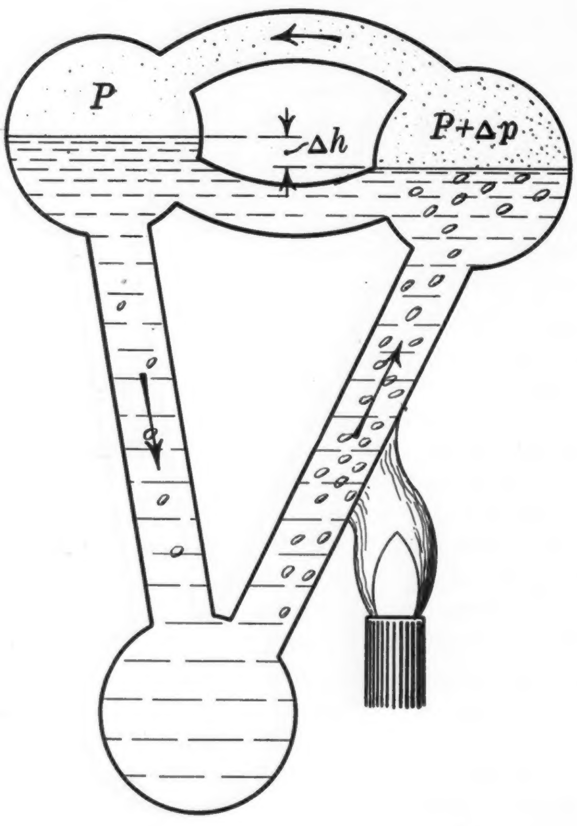


Diagram for bent tube boiler, showing circulation and possible depression of level by $\triangle h$ due to pressure drop $\triangle p$ through circulators

of the circulators between drums. If all the steam and water from the water walls be discharged into the front drum without adequate release for either steam or water, the resulting water levels may be such as to reduce the total steam space materially with a consequent limitation in the output of the unit.

The correct design of a boiler for the production of dry steam at high ratings involves a careful consideration of all the foregoing factors taken together. For design purposes, certain relations have been determined which simplify the problem somewhat. It has been found, for example, that for similar plant conditions, good operation permits a ratio of steam volume to steam space which varies with working pressure; this ratio is a measure of the velocity of the steam at which water settles out. But it must be kept in mind that the character of the boiler water, and even the rate of evaporation from the heating surface, has an influence on this settling velocity. Bent tube, multi-drum boilers follow the same general laws as straight tube, cross drum boilers but require more steam space than the latter, in the ratio of about ten to four, which may be attributed to the fact that in the bent tube type there is a serial separation of the moisture in relatively smaller drums over agitated water surfaces.

When foaming waters occur and where sudden fluctuations in loads occur the capacity of the drums must be increased.

Marked success has been attained by the use of drum baffling in further increasing the output of steam drums. Their use can be recommended after a careful design and proper feedwater treatment have been provided. Baffles can be made to improve good steaming conditions, but cannot correct basic faults in circulation, foaming water, and insufficient steam space.

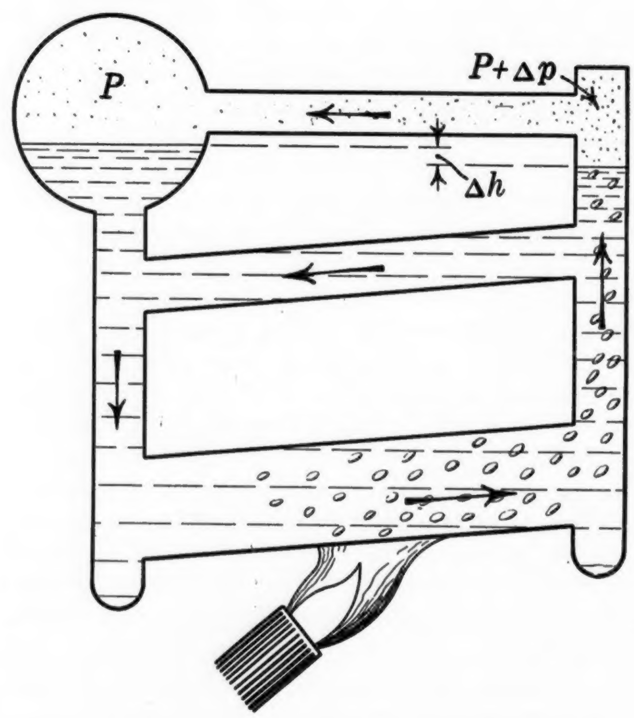


Diagram of straight tube boiler, showing circulation and possible depression of level in high header

For further studies on the application of baffles to effect separation, the reader is referred to the following:

"Studies of Moisture in Steam at High Rates of Evaporation," by A. R. Mumford, New York City, April 1, 1929 meeting, Met. Sec. A.S.M.E., Power Division.

"Scaling of Superheaters," Page 20, of the "Report of Prime Movers Committee," 20th Annual Convention of the Pennsylvania Electric Association, Bedford Springs, Pa., September, 1927.

Feed Water Treatment *of* Special Importance *at* High Rates *of* Evaporation

By A. R. Mumford

New York Steam Corporation, New York

THE insistent demand for the generation of greater quantities of steam from each unit of heating surface has emphasized the necessity for keeping such surfaces metal-clean. Five or six years ago the evaporation of seven pounds of water per hour per square foot of heating surface was considered to be operating at high capacity but today there are many plants evaporating twenty pounds of water per hour per square foot of heating surface and some of these plants have evaporated as much as twenty-five pounds per square foot of surface. In water walls the rate exceeds twenty-five pounds and maybe as high as fifty pounds per square foot of surface.

An increase in evaporation to about three times the amount of water per square foot of heating surface considered normal a few years ago, has highly accentuated the problem of scale on boiler tubes. The modern method for solving this problem is not mechanical cleaning but chemical treatment of the feed water. Mr. Mumford has had intimate experience with this problem, and his exposition will prove of great interest to all who are concerned with the operation of modern, high duty boilers.

Because soluble substances are precipitated from solution at points of greatest concentration, it is evident that the increase in rates of evaporation must cause more rapid concentration of dissolved solids at the water side of the heating surface and consequently an increase in the rate at which those substances, whose solubility decreases with increase in temperature, must deposit on the heating surface. The flow of heat from the products of combustion to the boiler water must be especially free of abnormal resistance at high rates of evaporation because the temperature gradients involved will cause the burning of the tube metal when they are elevated by abnormal resistance. Although scale in any thickness has never been desirable, it has become apparent that a scale 1/16 of an inch in thickness which, five years ago, could await an opportunity for cleaning will today force an immediate shut-down because of burnt tubes. A scale thickness of 1/32 of an inch and even 1/64 of an inch interposes enough resistance to the flow of heat at high rates of evaporation to cause the destruction of the heating surface by burning.

Referring to Fig. 1, it can be readily seen how the interposition of such an abnormal resistance as a layer of scale results in an elevated temperature of the metal of the tube. Normally the boiler tube has a temperature only 50 or 75 degrees above the boiler water but, with the scale on the surface, the temperature of the boiler tube rises to three or four hundred degrees above the temperature of the boiler water. In both parts of Fig. 1, the boiler water is considered as being at the same temperature. There is a slight rise in temperature to the surface of the dead water film. This rise in temperature represents the difference in heat head necessary to transmit the heat to the water. The transmission takes place by conduction, convection and condensation. The dead water film is of unknown thickness but is stagnant and heat transmission through it is largely by conduction. The thickness of this water film depends largely on the rate of circulation.

The conductivity of the metal of the boiler tube is so high that, for the amounts of heat normally transmitted through it, the temperature drop or necessary heat head is negligible. The greatest resistance is offered by the dead gas film on the gas side of the heating surface and this film accounts for most of the temperature drop between the products of combustion and the boiler water. The thickness of this film was determined roughly in some experiments made by the Bureau of Mines on a lower pressure boiler than is common now in the larger power plants. A postage stamp was pasted on the fire side of a tube and the boiler put on the line. The stamp was undamaged when the boiler came off again. Another stamp was pasted on top of the first and it was undamaged. The third stamp, however, was scorched so the thickness of the dead gas film is somewhat less than 1/100 of an inch. This film thickness is also influenced by gas velocity, because the eroding action of a swiftly moving gas stream keeps the dead film thin.

The foregoing resistance may be termed normal whereas the layer of scale is abnormal inasmuch as it can be removed without change in design. The scale film is on the water side of the heating surface and offers considerable resistance to the flow of heat so that, for the same rate of heat transmission the metal temperature of the boiler tube rises and the tube overheats.

Usually a tube overheats first at some particular point and its strength is reduced sufficiently to cause the tube to expand outward, because of the pressure behind it, into what is commonly known as a bag. This process continues until the bag bursts or, as is

more often the case, burns through at the summit of the bag and the tube fails.

Examination of a number of bags in the past five years has indicated a rather unusual condition in nearly every instance. Referring to Fig. 2, which represents a section through a bag, it can be seen that there are three layers. The boiler tube is lined

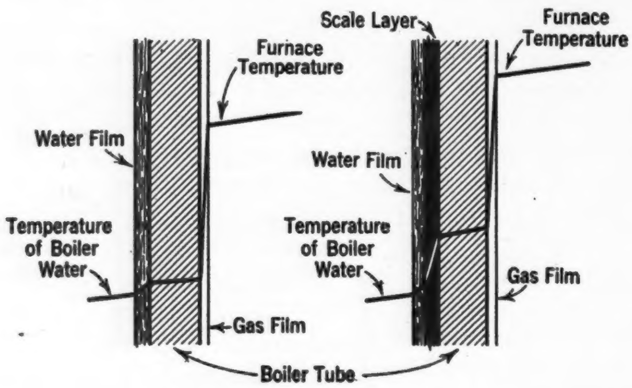


Fig. 1. Diagram showing effect of scale on the temperature gradient through a boiler tube

with a layer of scale, generally thicker on the hot side of the tube than on the cold side. At the bag there is usually a layer of magnetic oxide of iron between the scale layer and the tube. Speculation as to the formation and significance of this layer leads to the following explanation. As the layer of scale increases, the temperature of the tube metal increases and steam is formed between the scale and the metal. This steam may be formed from water seeping through the scale or from dehydration of the scale itself. However it may be formed, the steam is a good insulator and increases the rate at which an incipient bag approaches the point of failure. The increased resistance further raises the tube temperature and finally a point is reached hot enough to break down the steam into its components, hydrogen and oxygen. In the High School laboratories we passed steam over heated iron filings and produced magnetic oxide; here, between the scale and the tube, the same action is apparently taking place. Certainly we know the material is there when the failure has not been of two great a magnitude to destroy the conditions. The significance of the presence of the magnetic oxide was rather dramatically expressed by one engineer when he said that "the tube is burning from both sides." In spite of the shock of the idea that a boiler tube may burn from the water side, the statement is literally true.

All of the foregoing effects of scale in boiler tubes are emphasized by higher rates of heat transmission. Nowadays scale should be completely absent or at worst very thin because the formation is speeded to such an extent that failure takes place too soon after formation to permit of being caught by inspection. There has been no emphasis placed on efficiency and capacity as affected by scale because loss of a few points in either case may be permissable in order to keep "on the line," but in no case is the removal of a boiler from the line for tube failure accompanied by only a minor expense.

In considering the elimination of scale only two methods which are in general use will be mentioned. These are the physical removal of the material by some form of cutting tool and the chemical control of the boiler water so that the characteristics of the soluble substances are changed, and as a result do not adhere to the heating surface when they are precipitated from their concentrated solution.

Boiler cleaning is so generally known and understood that little need be said about it. All boilers have had to be cleaned more or less frequently in the past and all boilers will probably have to be cleaned at intervals in the future. The period of cleaning depends on the quantity and composition of the makeup water. It is axiomatic that with a 5 per cent makeup there will be less cleaning than with a 90 per cent makeup, other conditions being the same. However, the modern unit of high capacity represents a very considerable investment and apart from the danger of interruption due to failure the loss of production during the cleaning period is heavy. This appears in the carrying charges and is directly chargeable to mechanical cleaning. The design of modern units with the introduction of water walls does not lend itself to as short a cleaning period as

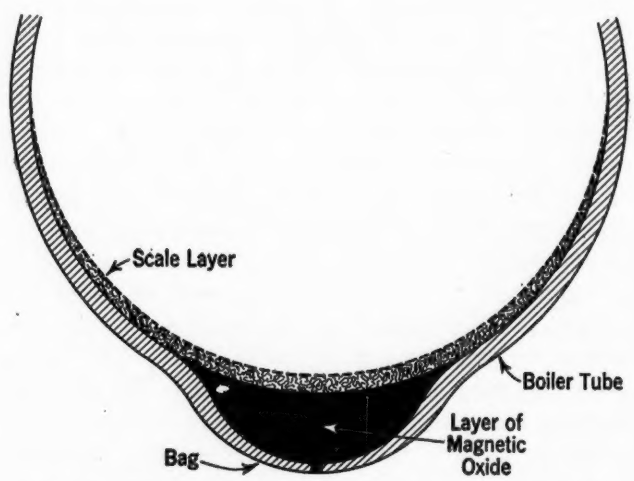


Fig. 2. Typical section through the bag of a boiler tube

the simpler low capacity designs did so that there are several reasons why the mechanical cleaning of boilers should be supplemented and probably eventually replaced by chemical conditioning of the boiler water to prevent the formation of adherent scale.

At the rate of steam production normal to the boilers in Kips Bay Station of the New York Steam Corporation, it has been estimated that a scale 1/32 inches in thickness would be laid down on each square foot of heating surface in twenty days. Probably, because of the different rates of evaporation on different parts of the heating surface, dangerous thicknesses of scale would be deposited

on parts of the heating surface in ten days. This, by the way, is with New York City drinking water which ranks very highly as a water supply. The cleaning of such a boiler would take one week and consequently, exclusive of failures, the productive investment would be reduced at least 25 per cent if mechanical cleaning alone was depended upon for removal of scale.

The chemical system of boiler water conditioning in use at Kips Bay Station, as well as all other stations of the New York Steam Corporation, was developed by Dr. R. E. Hall of Pittsburgh. Essentially this system consists of forcing the precipitation of the calcium as a phosphate rather than a sulphate because the phosphate is more soluble at the heating surface than in the center of the boiler tube, whereas the sulphate is less soluble at the heating surface. This solubility temperature relation causes the phosphate salt of calcium to form a non-adherent precipitate whereas the sulphate salt would, if allowed to form, precipitate as a tightly adherent scale.

The conditions necessary to the proper conditioning of the boiler water are essentially the maintenance of an excess amount of free phosphate in alkaline solution in the boiler. The purpose of the free phosphate is obviously to have available at all times sufficient phosphate to satisfy the calcium and to force the reaction in the desired direction under the mass action law in the presence of the increasing free soluble sulphate concentrations. The purpose of the alkaline solution is to force the precipitation of tri-calcic-phosphate rather than di-calcic-phosphate because the tri-calcic salt is completely non-adherent while the di-calcic salt is somewhat adherent.

The necessary alkaline solution is easily obtained by the use of tri-sodium-phosphate as the conditioning chemical in most neutral waters, but waters which are either normally acidic or normally basic will require modifications to suit their special characteristics. The composition of some waters containing carbonates alters in the boiler where the carbonates break down and the result is the release of carbon dioxide gas with the steam and the rapid increase of caustic concentration in the boiler. The foregoing action does not take place with any completeness at pressures below 150 pounds gage but above such a pressure the speed with which the carbonates break down increases rapidly with the pressure. This caustic, formed by the breakdown of carbonates, is in some cases sufficient to necessitate a change in the conditioning chemical from the tri-sodium phosphate to the di-sodium salt in order to offset the excess caustic. The necessity for offsetting the excess caustic is evident from recent discussions concerning the specific effect of caustic concentration on the moisture content of the steam leaving the boiler. Should the makeup water be particularly high in carbonates an even less basic salt than the di-sodium-phosphate might have to be employed.

The nature of the temperature solubility relation of the tri-calcic-phosphate causes it to begin to precipitate in the feed lines and economizers where the temperatures are low, if the conditioning chemical is added at some convenient point such as the feed water heater.

There are at least two ways of preventing the deposition: first, the addition of another chemical such as Cutch (a vegetable extract) which decelerates the chemical reaction between the conditioning chemical and the calcium, or, second, the installation of a high pressure chemical system which forces the conditioning chemical directly into the boiler. This latter system is a positive answer to the question of feed line deposit and has the further advantage of simple control to individual boilers.

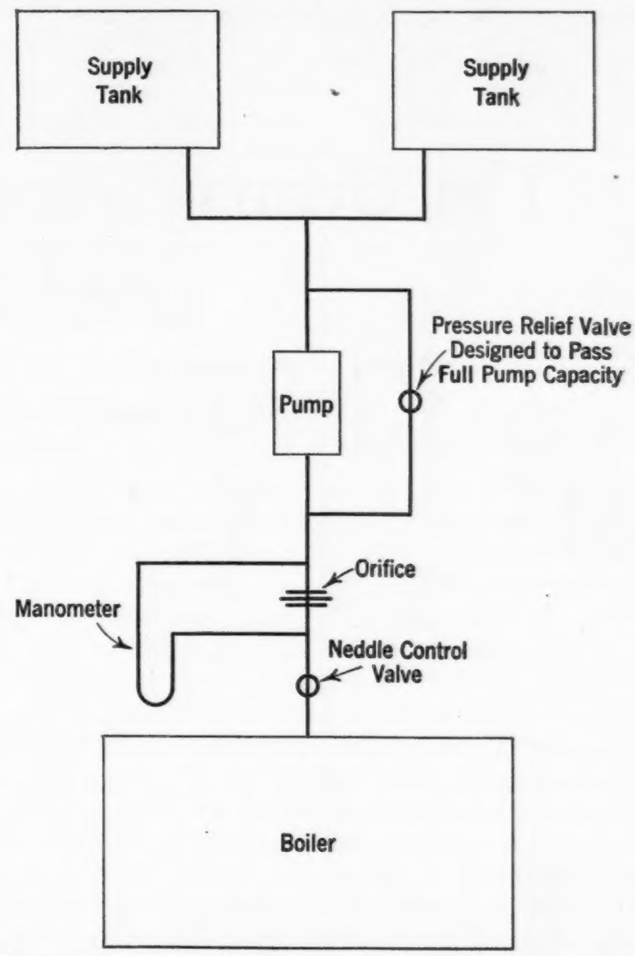


Fig. 3. Diagram of high pressure chemical water treating system

This system is shown diagrammatically in Fig. 3. Only the control valves are indicated, to simplify the diagram.

The pump can be installed with sufficient capacity for the ultimate installation provided the relief valve is designed for continuous operation. The orifice and manometer are usually mounted on the boiler control panel together with the needle control valve. The boiler operator, by operating the needle valve, keeps the indication of the manometer in

exact relation to the flow chart of steam from the boiler and in this manner exactly the right quantity of chemical is being added at all times. The nature of the conditioning chemical is altered to suit conditions in the boiler as found by daily analyses of the water.

If there is an incidental problem, such as economizer corrosion, this system is flexible enough to permit of adding one chemical to the feed water heater to inhibit corrosion and, if this chemical is harmful in the boiler, it can be readily made ineffective by a change in the nature of the conditioning chemical.

Single boilers using the system developed by Dr. Hall have, within the last year, evaporated a billion and a half pounds of water containing 40 parts per million of dissolved solids with no more than two and in some cases only one mechanical cleaning.

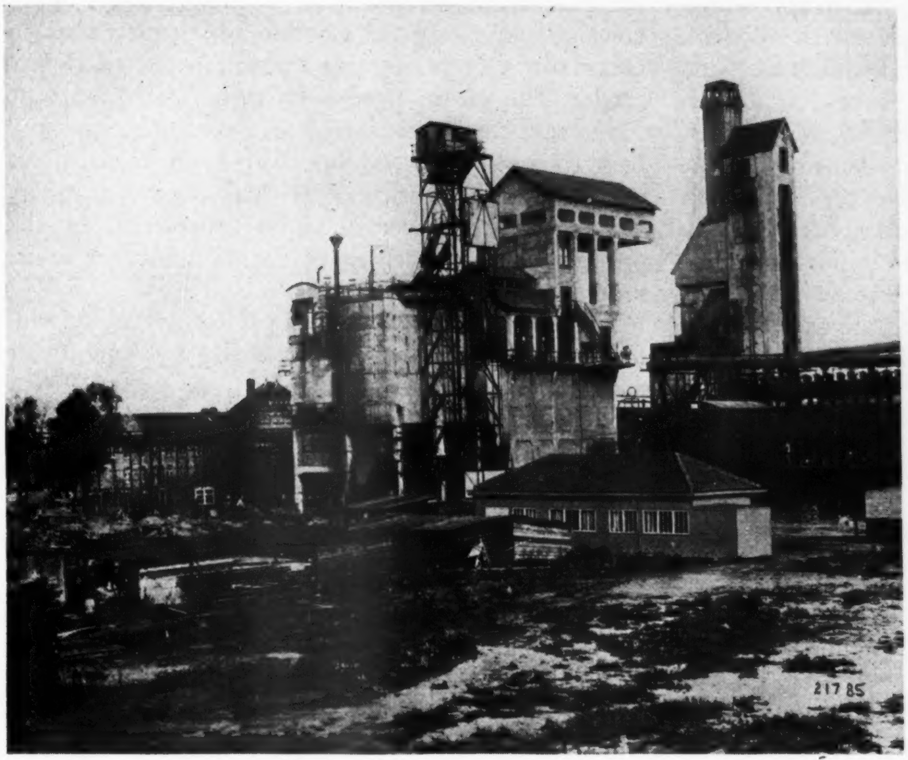
The problem of the boiler plant is being recognized as one of the most intricate physical chemical problems as our knowledge of what takes place increases. Some of us may long for the days when the problem was to keep the fires clean and free and to keep water in the glass but it seems as though "them days are gone forever."

The German View *of* Powdered Fuel *and* Stokers

Digest of a recent article by P. Rosin, of Dresden, in *Archio fur Wärmewirtschaft und Dampfkesselwesen*

MANY persons in Germany have asserted lately that powdered-coal firing is becoming obsolete. Mr. Roskin of Dresden, who recently visited America, did not notice any such thing here. On the contrary he found a slight prevalence of powdered-coal firing in newly built large central stations, and he points out one material difference between German and American central-station practice which may have a bearing on the situation. In Germany more than half of the power generated comes from stations using brown coals as fuel, while in America lignites and brown coals are of little or no importance. American bituminous-coal-fired plants are in nearly every case located near water and often receive their coal from considerable distances and pay high freights—at times equal to the price of coal at the mine. This means that fuel is expensive and their main effort is to obtain as low a fuel consumption as possible, coupled with the ability to use all kinds of coal. Americans apparently find that powdered-coal fuel has a slight advantage over other forms when it comes to satisfying these two conditions. It is also significant that powdered fuel is predominantly used in America with coals having a high heat content, while in the case of lower-grade fuels the increase in cost due to the expense of drying and pulverizing them seems to be considered very seriously indeed. In Germany the migration of power plants to the waterside is not so pronounced. In the first place, the plants are smaller, and in the second place, large rivers, lakes, and ocean frontage are not as available in the industrial regions in Germany as they are in the United States. The tendency exists, however, and for a German it would not be safe to express too positive an opinion as to what will happen in the central-station field there as regards combustion systems.

Mr. Rosin found in the American power plant field many evidences of the competitive spirit between pulverized-fuel firing and stoker firing. It appeared to him that this competition between powdered-fuel and stoker firing is carried on in a much friendlier spirit in the United States than in Germany, due probably to the fact that the leading combustion-engineering concerns in America build both types of firing equipment. In America it is not "either one or the other" ("Entweder-Oder") as is the case in Germany, but a question of considering the practical features of the two systems and arriving at a proper solution. Such problems as the increase of velocity of combustion, turbulence, study of aerodynamic conditions in the firing chamber, the use of primary and secondary air and air preheating, water cooling of furnace walls, ash handling, etc., are all being considered in order to arrive at a proper selection of the furnace type. Competition, Mr. Rosin remarks, is always a good thing for progress, but this does not mean that problems affecting all competitors together should be overlooked, or that because of competition there should be no cooperation toward their solution. The fundamental problem of all combustion methods is the burning of fuel, and our knowledge of it is still capable of vast improvement.



This description of the conversion of an economic waste into a profit is especially interesting because of the very simple expedient used to accomplish the result. There should be inspiration as well as instruction in this story. In all phases of fuel utilization, engineers are working hard to conserve every heat unit. Dry quenching is one of the milestones along this road.

Dry quenching equipment and screening plant of the Rotterdam Gas Works at Rotterdam-Keilehaven.

Practical Economies *from* Dry Quenching *of* Coke

By W. Sennhauser
Dry Quenching Equipment Corporation, New York

THE energetic modern activity in discovering sources of economic waste and converting wastes into savings, has resulted in a peculiar but commercial saving in the coke industry. The necessity for utilizing every possible source of energy in this industry was perhaps felt rather more strongly in Europe after the war than in this country. It would hardly be supposed that the familiar expedient of cooling hot coke by quenching it with water would offer an opportunity for a practical and commercial saving. This cooling process has always generated clouds of steam to be sure, but this steam was, of course, at atmospheric pressure and mixed with various gasses from the coke; the possibility of conserving the heat represented by this steam seemed remote indeed. Nevertheless, this problem in conservation of energy has been successfully solved, and as in many another apparently unsurmountable problem the solution involves a process of extreme simplicity.

A somewhat detailed description of the ordinary wet process of quenching coke as used in practically all plants previous to the advent of the dry quenching process will serve to make clear just to what extent the dry process differs from the old wet process. The coke at a temperature of 1800 to 1900 deg. fahr. is pushed from the coke ovens into a quenching car. This car, which is usually on a standard gage track, is then run under a quenching tower where it is thoroughly sprinkled with water until it is cool enough to be put onto a rubber belt for further transportation and handling. By the time the large coke pieces are sufficiently cool, the small pieces are already soaked with water, thus producing a coke of very irregular moisture content. The draining water washes away part of the breeze which usually is too wet to be used as fuel.

In many of the European plants, the coke is not only sprinkled, but completely submerged in water and contains, therefore, when cold, a very high percentage of moisture. There is also evidence to show that excessive use of water in quenching causes the coke pieces to crack, and this increases the proportion of breeze and small sized coke. It is evident that these methods of wet quenching waste completely the sensible heat of the coke, reduce the quality and calorific value of coke, and cause a nuisance in that the quenching vapors carry a great quantity of fine particles into the atmosphere, to be scattered over the plant and surrounding territory. Serious trouble

is also experienced in winter time, due to the formation of ice from the quenching water and the quenching cars require a great deal of maintenance and repair work.

During the war, Sulzer Brothers in Winterthur, Switzerland, began to pay much attention to the question of heat conservation of every kind; and they developed a method of dry quenching of coke that has found a wide commercial application. The method they employ is quite simple, and very effective. The hot coke is pushed from the ovens into a car, whose contents are transferred to a sealed cooling chamber through which an inert mixture of gas is continuously circulated. In this chamber the gases extract the sensible heat from the coke and carry the heat through a steam boiler, where the heat is transferred to the water in the boiler, thus producing steam. A fan draws the cooled gases from the boiler and pushes them again through the coke bed, thus securing a continuous circulation of gas through an entirely closed system. This cycle is illustrated in Fig. 2, which represents a typical longitudinal section through a dry quencher.

The chamber is brick lined and holds a number of oven loads, which allows the coke to remain in contact with the circulating cooling gases for a period of about two hours. The chamber has a charging door on top and a discharging door at the bottom. Whenever a new load of hot coke is ready to be charged to the chamber, an equal amount of cooled coke is withdrawn from the bottom, but at no time will the chamber be empty. Each charge of coke gradually works lower and lower until it is finally discharged. In this manner continuous operation is secured, although the supply of hot coke to the quencher is intermittent. The coke in the chamber and the water in the boiler constitute a heat accumulator of considerable storage capacity, which renders the steam production practically constant. The steam can be generated at a pressure and superheat to meet the usual operating conditions of gas works and coke works. Very often the steam is used for generating power in turbo generators; 250 lb. pressure and a superheat of 200 deg. fahr. is easily secured.

The cooling gas is not supplied by an outside source, but is formed automatically by starting up the dry quencher. As soon as the first load of hot coke is introduced, the oxygen in the system is quickly consumed, leaving mainly nitrogen and CO_2. A small portion of CO_2 is reduced to CO by contact with glowing carbon according to the prevailing temperature at any particular time. Though the fan maintains pressure and suction zones in the plant, there is no introduction of air or loss of gas while charging or discharging coke. The closed system can be opened at any one point, which immediately becomes the zero point of pressure, this allowing no gas to be pushed out, nor air sucked in through that opening. If, however, two doors should be opened simultaneously, air would enter through one door and gas would be pushed out through the other.

The coke in the container very often continues to give off volatile matter, mainly hydrogen, which would accumulate, if no means were provided to burn it off. This gas combustion takes place during charging of hot coke while the top door of the container is open. The hot gas rises through the door by virtue of its low specific weight and cool air

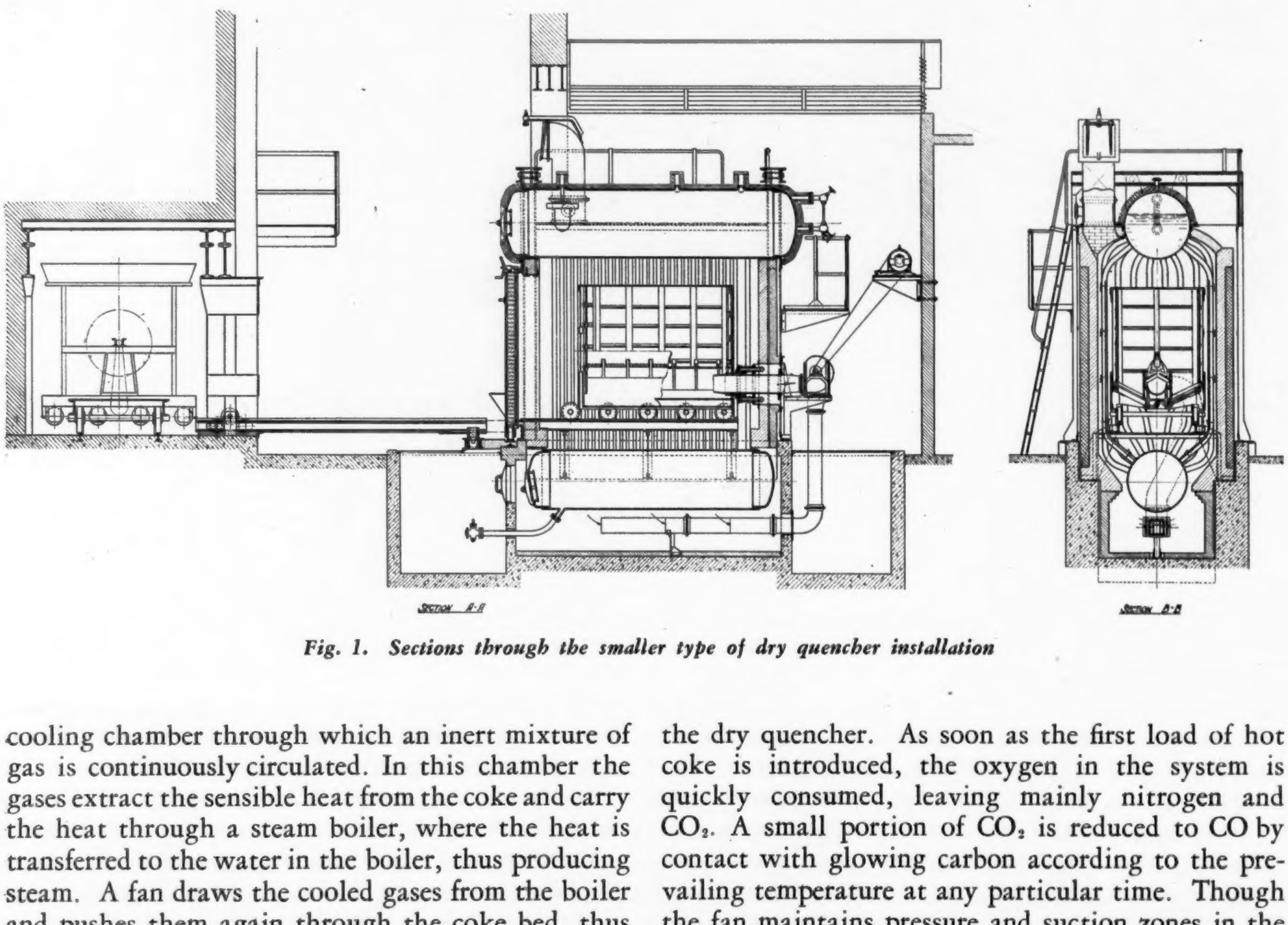


Fig. 1. Sections through the smaller type of dry quencher installation

enters, thus mixing with the hydrogen and consuming it quickly. Part of the heat generated is carried over into the boiler by the circulating gas and is recovered in the form of steam.

A few typical gas analyses are given below, taken from operating records of the dry quencher of the Rochester Gas & Electric Corporation, at Rochester, N. Y.:

Sample	CO_2	O_2	CO	H_2	CH_4
1	11.9	.0	9.4	x	
2	10.5	.2	2.6	x	
3	9.5	.0	7.9	x—	
4	7.5	.2	6.5	16.9	.7
5	7.3	.0	9.1	13.4	.7
6	5.3	.3	9.0	22.6	1.4

x—Less than 10 per cent.

The Sulzer system of dry quenching can be used in combination with all types of coke ovens; continuous ovens, of course, excluded. Two types of apparatus have been developed, based on the same principle of cooling with inert gas, but somewhat different in design, each type having its own field of application. One type consists of a stationary chamber as already described, holding a number of loads of coke and in permanent connection with a boiler plant. The hot coke is handled by means of a bucket hoist into which the coke has been dumped from the hot coke car, or by hoisting up the entire car by means of a platform hoist or with bail and hook. The cooling gas is continuously circulated through chamber and boiler.

It has been found that vertical fire tube boilers are particularly well suited to be used in connection with this type of quencher. The gases enter the boiler on top and leave it at the bottom, where the dust, carried over from the chamber settles out in a special dust catcher before the gases enter the fans. No difficulty has been experienced with this dust, since means are provided to remove it from time to time. The tubes are always found to be clean because the dust is absolutely dry and has not the slightest tendency to adhere to the tube walls.

Horizontal fire tube boilers have also successfully been used in a number of plants. They may, under certain conditions, offer a better arrangement of gas passages than vertical boilers.

In other cases, the requirement of higher steam pressure has made it necessary to use water tube boilers with brick lined and insulated casings. Due to somewhat lower gas velocity, a larger heating surface of water tube boilers is necessary than in the case of fire tube boilers.

The second type of dry quencher is shown in Fig. 1 and is used particularly in medium and smaller gas plants. It has a movable container in the form of a cast iron lined coke car, into which the coke is dumped directly from the ovens. This car is then conveyed to the quencher, consisting of a vertical water tube boiler, the tubes of which form the cooling chamber. The car with the hot coke is run inside this chamber and the door is closed. In the bottom of the car is a gas distributor, which is automatically

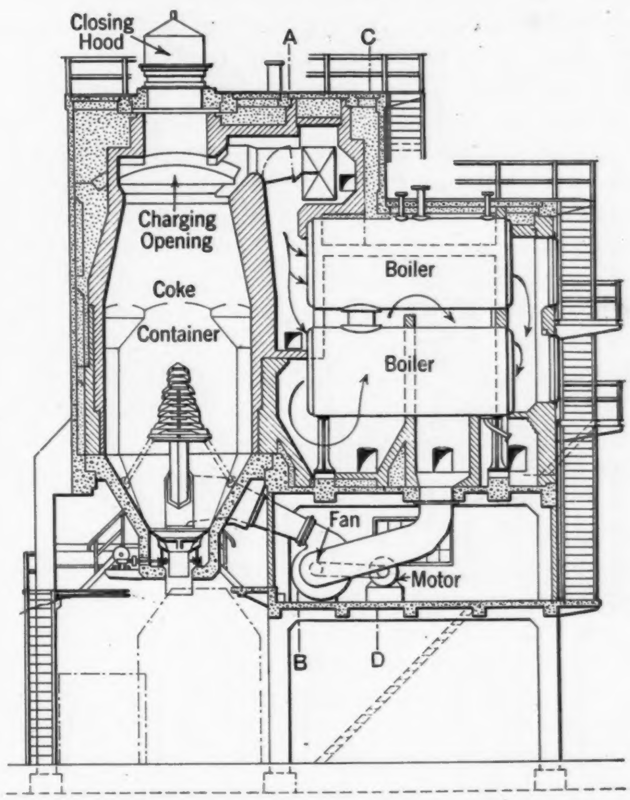


Fig. 2. Section through the larger type of dry quencher

connected with the fan pressure duct when the car is placed in position in the chamber. The fan is started and the gas circulated upwards through the coke and downwards along the boiler tubes and is conducted to the chamber underneath the lower boiler drum, whence it is drawn off by the fan and recirculated.

This type of dry quencher has the distinct advantage of reducing coke handling to a minimum. The hot coke hoist is eliminated, saving the cost of that item completely. The necessary heating surface, however, is greater for a given capacity than in the first type of dry quencher, due to the lower mean temperature difference between coke and boiler water. In this second type each load must be cooled down to discharge temperature and the gas temperature drops, therefore, to almost steam temperature. The boiler, necessarily has to act as a heat accumulator during the time when the coke car is discharged and must be designed accordingly. If, however, a

number of units are coupled together, the steam generation can easily be equalized as far as it is necessary for practical operation.

The operation of these dry quenching plants is extremely simple. One man, often the car driver, or the wharf operator, can operate the coke handling devices, and in case of smaller plants, can attend to the boilers. In larger plants all or at least part of a second man's time is required for attending to boilers, fans, and hoisting equipment.

The principal benefit of dry quenching is the production of 900 to 1000 pounds of steam per ton of coke cooled, as evidenced by years of operation here, as well as abroad. The specific heat of various kinds of coke as a function of the temperature is well known today. The heat available for steam production by recovering the sensible heat of the coke is easily calculated. Coke of 8 per cent ash and 2 per cent volatile pushed from the coke oven at a temperature of 1850 deg. fahr., has a mean specific heat of .361 and its heat content is therefore, 1850 $\times$ .361 = 666 B.t.u. per lb. If the coke is cooled to a temperature of 700 deg. fahr. its mean specific heat is .275 and its heat content is then 700 $\times$ .275 = 192 B.t.u. per lb. The sensible heat available is, therefore, 666 − 192 = 474 B.t.u. per lb., and with this amount of heat, figuring an efficiency of about 92 per cent, 900 lb. of steam from and at 212 deg. fahr. can be produced per ton of coke. Actually 900 to 1000 lb. of steam, from and at 212 deg., are generated per ton of coke, the balance being due to combustion of volatile matter as explained above. As far as can be determined, no combustion of coke takes place as the gas analyses show an oxygen content of zero or only a fraction of one per cent at the inlet into the container.

Besides the generation of steam, there are a number of other advantages to be attributed to dry quenching, although they may not always be expressible in terms of dollars and cents. There is no question that dry coke has a higher thermal value than wet quenched coke and this improvement of the coke quality must be of benefit wherever coke is used as fuel. The disadvantage of wet quenching lies not only in the moisture content, but also in the fact that the moisture content is not uniform, certain parts being overquenched. This is a hindrance in obtaining a uniform rate of combustion, especially in small domestic furnaces. Wet breeze and dust have a tendency to adhere to the large coke pieces and will only fall off when the mass dries out, and that is in the customer's bin. This is very often a cause of complaint from the customer, who claims he was supplied with dirty coke. A great advantage of dry quenching, therefore, lies in the fact, definitely proven, that dry coke can more easily be screened and a cleaner coke may be supplied to the domestic market.

The dry quenching process, as can readily be seen, involves more coke handling than wet quenching and it is a matter of fact that the dry quenched coke is somewhat smaller in size but it is much more uniform in size and physically stronger and consequently more resistant to further handling.

As outlined before, the fine coke usually is overquenched and therefore, its field of use as a fuel is limited. Recent experience, however, has definitely established the fact that in gas producer operation, smaller sized dry coke can be used to greater advantage than larger sized wet coke and it has been found that a reduction in fuel consumption is effected amounting to 10 lb. of carbon per ton of coal carbonized. The comparison was made with 7/8 in. to 3/16 in. dry quenched coke and 1 in. to 5/8 in. wet quenched coke.

Similar results have been obtained in water gas operation. Careful comparisons were made at the Rochester Gas and Electric Corporation plant to establish the difference in fuel consumption and a 5 per cent better fuel economy has been found. This astonishing result cannot be explained by accounting only for the heat necessary to evaporate the moisture. A cleaner fuel bed, facilitating the distribution of blast and probably an extension of the reduction zone, due to absence of moisture in the center parts of the coke pieces, may be considered as the determining factors.

Bearing these facts in mind, it is quite logical to conclude that similar results must be effected in blast furnace operation. Uniformity of the coke size and moisture content, greater physical strength of the coke pieces, and a clean fuel bed, will be of great help in securing uniformity and smoothness of blast furnace operation. Operation of European blast furnaces shows distinct advantages by using dry quenched coke and savings of from 2 per cent to over 4 per cent are reported.

The economic aspect of dry quenching may now be illustrated in a set up which is based on a daily cooling capacity of 600 tons of coke and figured out for one year's operation (350 operating days).

STEAM PRODUCED
950 lb. per ton of coke
950 $\times$ 600 $\times$ 350 = 200,000,000 lb. per year

EXPENSES

Labor
It is assumed that no additional labor is required

Maintenance
2 cents per ton of coke cooled
600 $\times$ 350 $\times$ 0.02 .... $4,200.00

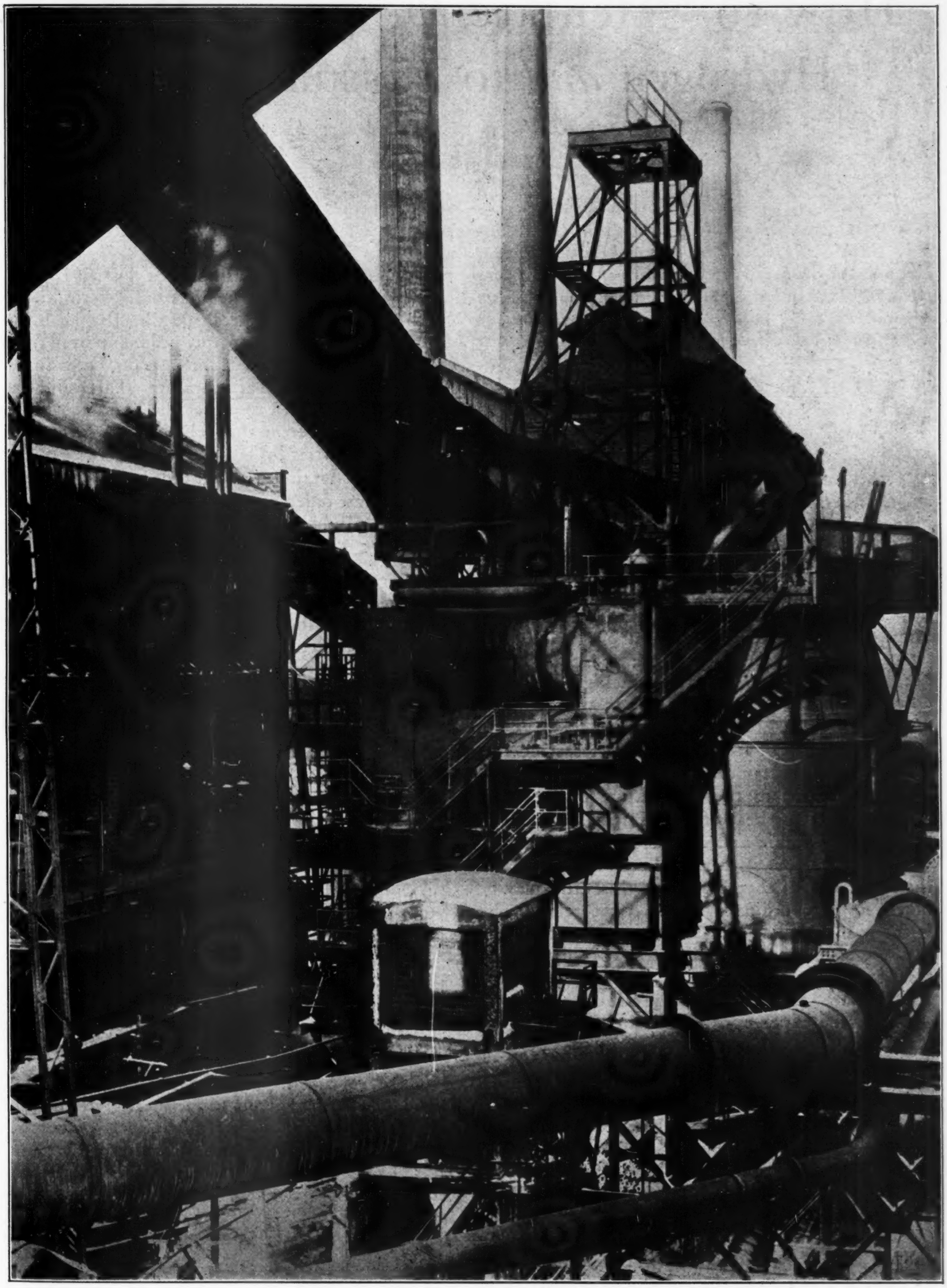
Power
For Fan and Hoist, 4.5 kw. hr. per ton;
1 cent per kw. hr.
4.5 $\times$ 600 $\times$ 350 $\times$0.01 .... 9,450.00

Operating Expenses $13,650.00

FIXED CHARGES
The total cost of a plant of 600 tons per day, including the hoist, has been estimated to be about $180,000.00. Fixed charges at 15 per cent,
0.15 $\times$ 180,000 =.......................... $27,000.00

Total Expenses $40,650.00

COST OF STEAM = 20.3 cents per 1,000 lb.



Dry quencher installation at Rochester Gas and Electric Corporation, Rochester, New York. This was the first dry quencher installation in America

How to Calculate *the* Losses Due to Hydrogen *and* to Moisture in Fuel

By B. J. Cross
Combustion Engineering Corporation, New York

Each month one of the important calculations in steam power plant engineering will be discussed in this department. COMBUSTION readers will find here the formulas that are used, with a short explanation of their derivation and use. The full page chart, for graphic solution of the formulas discussed, will save the busy engineer many an important moment during his frequent calculations.

When fuels containing hydrogen are burned, the hydrogen combines with oxygen of the air to form water vapor. When the heat value of the fuel is determined in the laboratory, this water vapor is condensed in the calorimeter and the latent heat of vaporization is included in the heat value reported. This value is called the gross or high heat value.

If the gross calorific value of the fuel is used, as is the practice in the United States, the moisture from the burning hydrogen must be considered as being evaporated at some temperature above that of the fuel and air entering the furnace and then superheated to the temperature of the stack gases. As we do not know exactly the temperature at which this moisture is evaporated, we are justified in assuming the simplest case. We may therefore assume this moisture to be evaporated at room temperature and then superheated to the temperature of the stack gases. The latent heat of vaporization at the temperature of the air and fuel entering the furnace may be taken from a steam table. For 70 deg. fahr. the latent heat is 1053 B.t.u. and this value may be taken for any ordinary boiler room temperature without introducing any serious error. If a more accurate result is desired the term 1053 may be replaced with the latent heat of vaporization at room temperature as taken from the steam table. In symbols, the expression for this loss is:

$$9H_2 \times [R + .47\,(T_2 - T_1)] = \text{B.t.u. loss}$$

H_2 is the fraction by weight of hydrogen in the fuel, T_2 the flue gas temperature, T_1 the room temperature, both in deg. fahr., and R the latent heat of vaporization at the room temperature.

In order to determine the value of this B.t.u. loss under any given conditions by the graphical method, the chart on the opposite page has been constructed from the equation given above. The vertical scale at the left is numbered to represent given values of the expression $T_2 - T_1$, and the B.t.u. loss is finally read off from the vertical scale at the right. Slope lines across the chart for various room air temperatures and for the per cent hydrogen by weight in the fuel, permit the instant use of any values for these variables.

In addition to the resulting B.t.u. loss, it is possible also, by means of the horizontal scale at the bottom of the chart, to read off directly the B.t.u. absorbed per pound of moisture heated up from room temperatures, evaporated into steam, and superheated to exit flue gas temperature. This value can be applied as desired to either the hydrogen in the fuel, or the moisture in the fuel, although its greatest use is for the latter.

For a fuel containing 5.0 per cent hydrogen and for a temperature difference of 500 deg. fahr. the loss per lb. of fuel would be:

$$9\,(.05) \times [1053 + .47\,(570 - 70)] = 579 \text{ B.t.u.}$$

To obtain this result from the chart, start with the temperature difference on the scale at the left, trace horizontally to the room temperature line, 70 deg. fahr., thence vertically to the 5 per cent hydrogen line. From this intersection trace horizontally to the vertical scale at the right where the loss in B.t.u. may be read.

For fuels high in hydrogen, such as natural gas, the decimal point on the hydrogen line may be shifted. Thus 2.5 per cent may be called 25 per cent. The B.t.u. loss must then be multiplied by 10.

The approximate hydrogen content of the more common fuels is given in the following table.

Anthracite coal	2.0 to 2.5 per cent
Semi-bituminous coal . .	4.0 to 4.5 per cent
Bituminous coal . . .	4.5 to 5.0 per cent
Sub-bituminous coal and lignite	5.0 to 6.0 per cent
Fuel oil	10.0 to 12.0 per cent
Natural gas	20.0 to 25.0 per cent
Producer gas	1.0 to 1.5 per cent
Coke oven gas	18.0 to 20.0 per cent
Blast furnace gas . . .	.25 per cent

The scale at the bottom of the sheet gives the heat lost per pound of moisture in the fuel, evaporated and superheated to the temperature of the flue gases. Thus at a 500 degree temperature difference, the heat per pound of water vapor from moisture in coal is 1288 B.t.u. If the fuel contains 5 per cent of moisture, the heat loss due to this moisture is .05 × 1288 or 54.4 B.t.u.

It will be noted that with zero temperature difference, the loss is approximately 1050 B.t.u. This is, of course, the latent heat of vaporization.

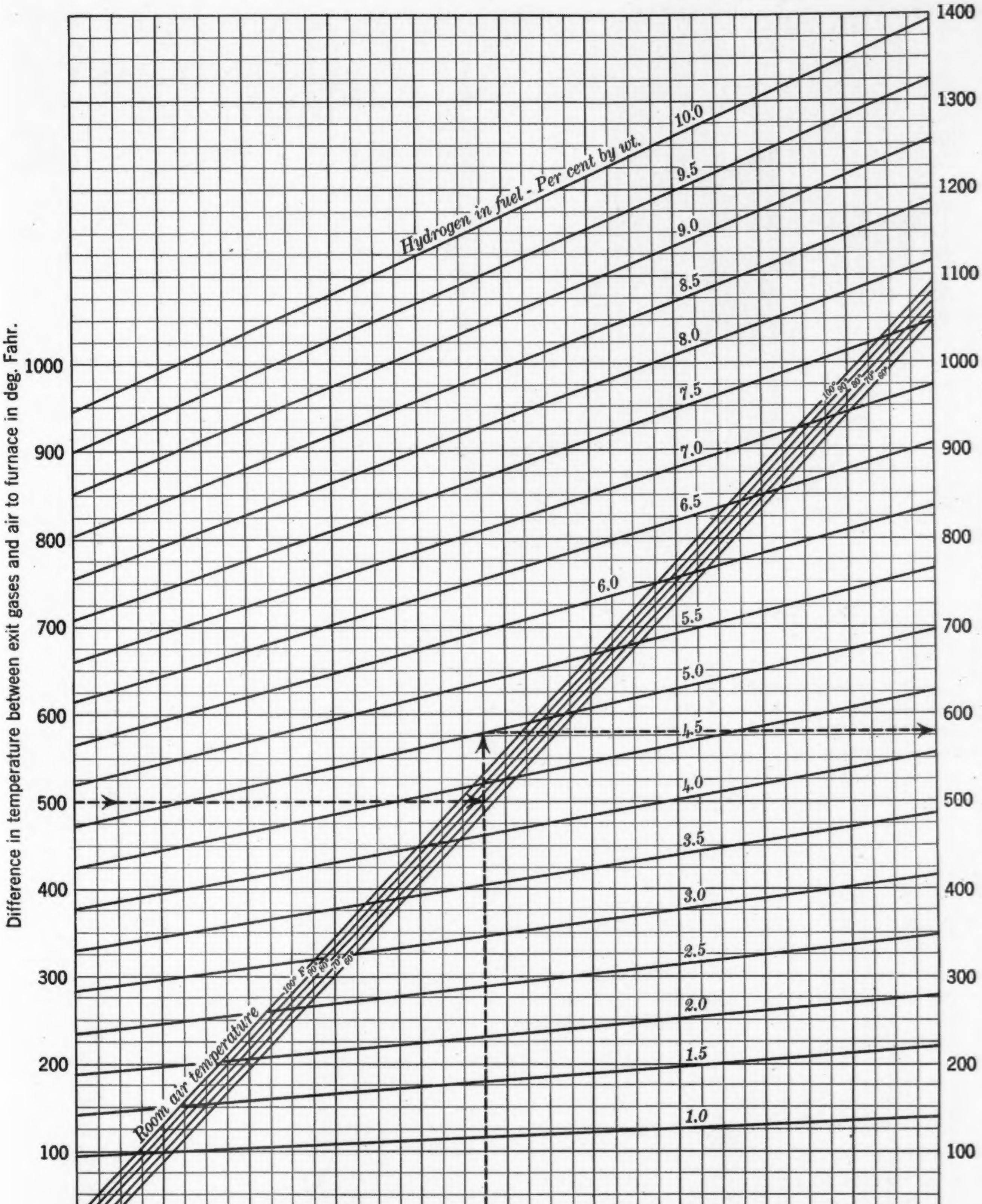
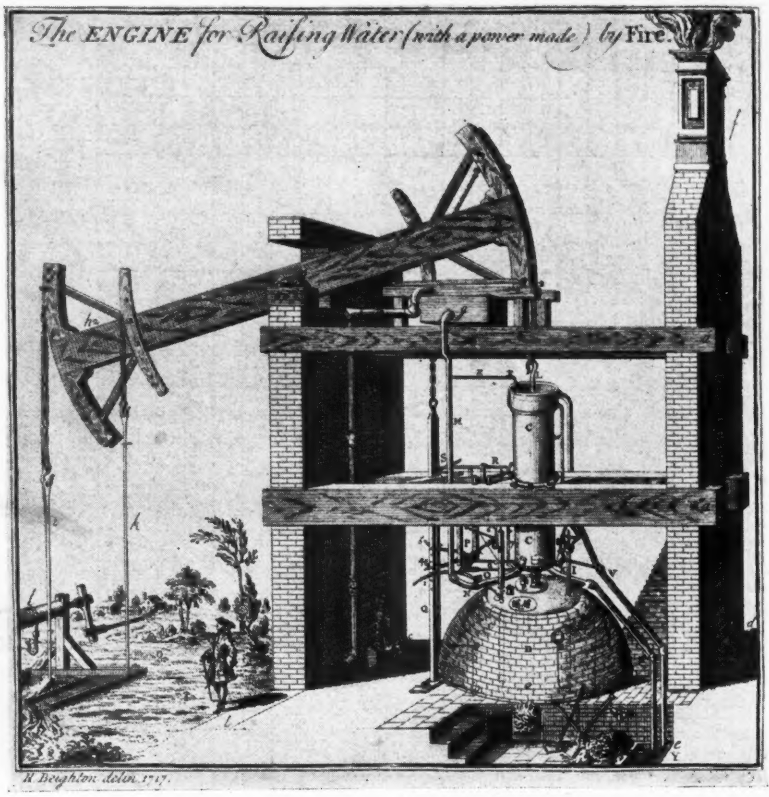


CHART FOR DETERMINING LOSSES DUE TO HYDROGEN AND TO MOISTURE IN FUELS

No. 2 of a series of charts for the graphical solution of steam plant problems



BI-CENTENARY MEETING *of the* NEWCOMEN SOCIETY

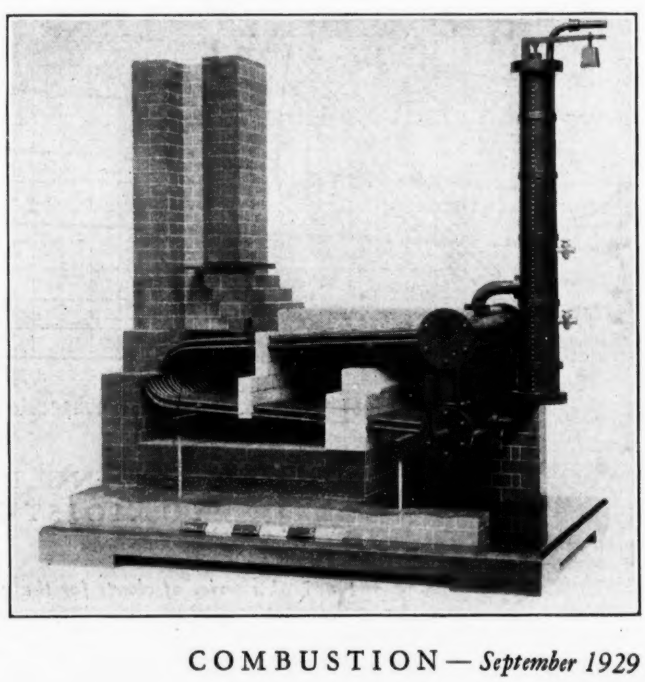
The illustration at the left is a drawing by Henry Beighton of an engine erected by Newcomen at Griff, near Coventry, in the County of Warwickshire prior to 1718. Below is a cut of one of the first water-tube boilers in the history of the world, invented by Sir Goldsworthy Gurney of Cornwall in 1825, being a detailed scale model made from the original drawings in the South Kensington Museum. This boiler was operated on steam coaches, and the water-tube boiler was working in England nearly half a century before the days of the "Belleville" and other French water-tube boilers.

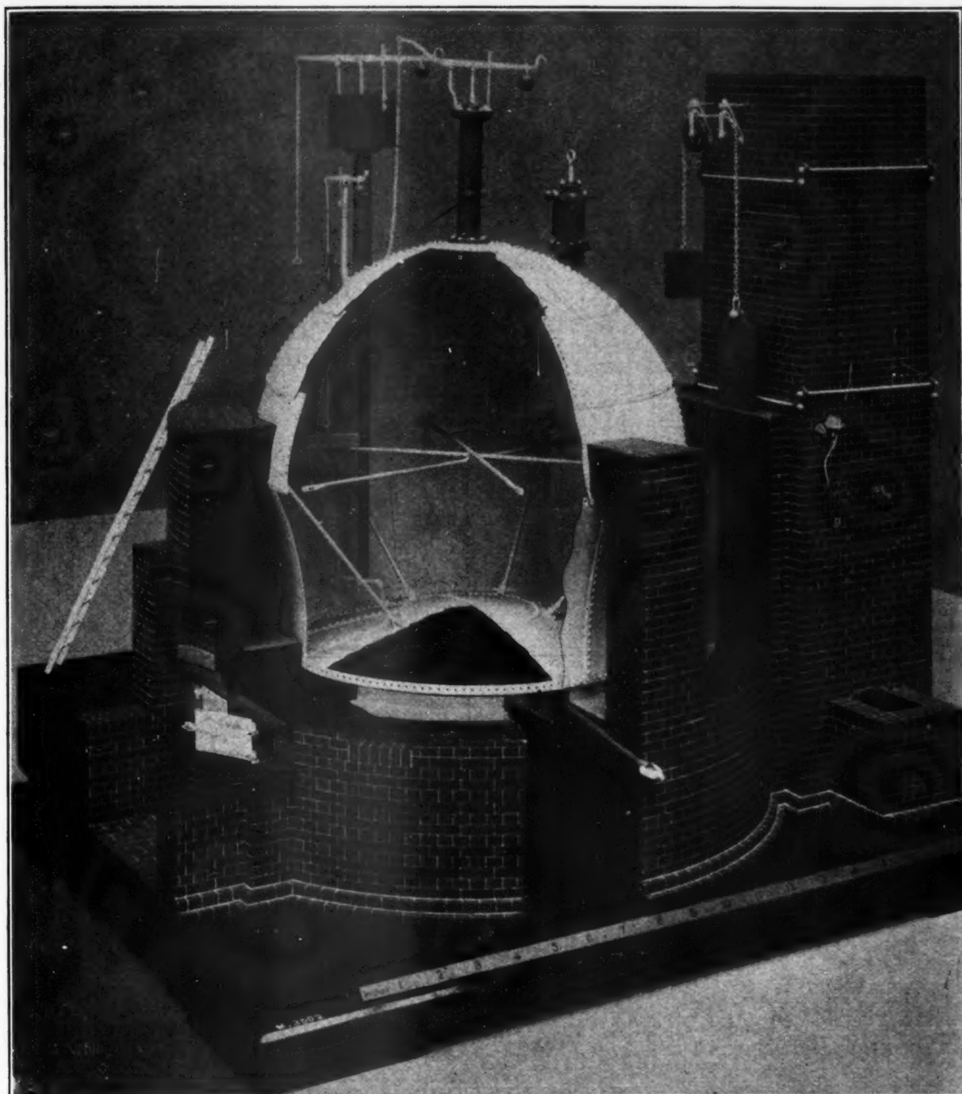
THE Newcomen Society for the Study of the History of Engineering and Technology held their Annual Summer Meeting this year at Dartmouth from the 23rd to the 26th July, in conjunction with the Devonshire Association, to commemorate the Bi-Centenary of the death of Newcomen.

The whole question of the history of the evolution of the steam boiler and engine is well known to be one of extreme complexity, but Newcomen was the first man in the world, somewhere about 1711 and after ten years' work, to produce a practical and successful steam pump, that is, the familiar "atmospheric" engine consisting of a beam, with a piston and cylinder for the water at one end and a piston and cylinder at the other end for the steam. The essential principle was the use of a boiler at only ½ lb. pressure, which subsequently evolved into the "Beehive" or "Haystack" boiler, so that when the steam piston rose the cylinder was filled with steam. This was then condensed by squirting in cold water, which caused a vacuum, and the piston was pushed down again by the atmosphere, thus giving a continuous reciprocating motion. Several hundred Newcomen engines were erected all over Great Britain during the following three-quarters of a century, and on the Continent of Europe as well, and about 1712, when Newcomen erected one of his first engines at Dudley Castle in Staffordshire, the modern era of steam had definitely commenced.

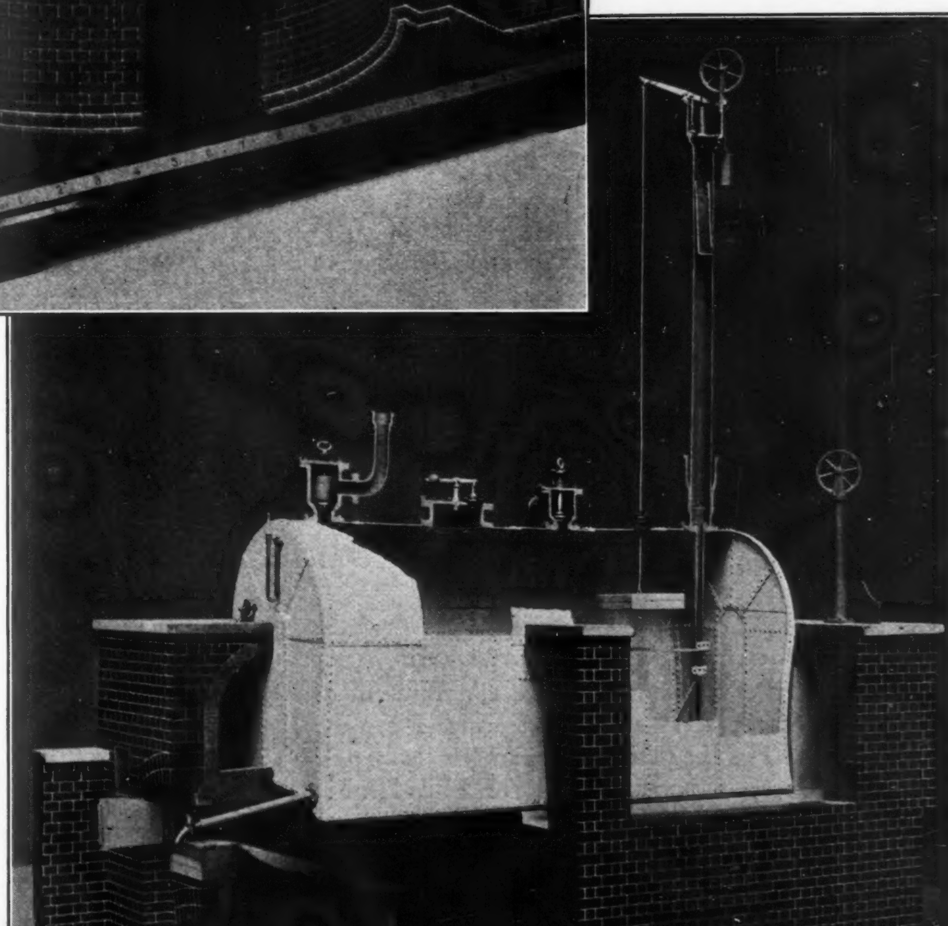
It was from the Newcomen engine many years later that James Watt conceived the idea of the separate condenser and invented the modern steam engine in the sense of being able to drive shafting instead of pumping water only.

The town of Dartmouth is situated at the mouth of the river Dart, and has many attractions for Americans, quite apart from its historical connection with Thomas Newcomen. The beautiful little natural harbor in the mouth of the Dart has been used for thousands of years past, by the Phœnicians, Romans, Danes, Saxons, and Norsemen. Richard Cœur de Lion assembled his fleet here when he went to the crusades in Palestine, and the town is associated with the historical names of Drake, Frobisher, John Davis, Adrian Gilbert, and many other famous seamen.





The "Haystack" boiler such as used regularly for the Newcomen engine. This is a photograph of a detailed and authentic scale model in the Science Museum, South Kensington.



"Wagon" boiler of James Watt, operating at 5 to 6 lb. pressure, which is really an elongated "Haystack" boiler. This boiler was rendered obsolete by about 1820 by the high-pressure internal combustion boiler of Richard Trevithick, undoubtedly one of the greatest engineers of all time, who invented the "Cornish" boiler from which eventually the "Lancashire" boiler was evolved.

· NEWS ·

The continued expansion of the Middle West Utilities Company system in the Southwest is indicated by the announcement that Central and Southern Utilities Company, a subsidiary, is planning the construction of a 30,000 kw. steam-electric plant near Laredo, Texas. Natural gas fuel is contemplated, and it is estimated that approximately 12,000,000 cubic feet of gas per day will be required to meet the load demands of the new plant.

Leeds & Northrup Company, Philadelphia, Pa., announces the appointment of the Irvin C. DeHaven Engineering Co., State Life Building, Indianapolis Ind., as exclusive sales representative for L. & N. Metered Combustion Control apparatus in Indiana (except the extreme Northern portion), Western Ohio and the State of Kentucky.

R. L. Sittinger, 80 Federal St., Boston, Mass., has been appointed exclusive sales representative for New England.

International Combustion Tar & Chemical Corporation, New York, announces the election of George E. Learnard as Chairman of the Board, succeeding F. J. Lewis; of Dr. Walter Runge as President, succeeding W. H. Lewis; and of Grant Thorn as Vice-President in Charge of Sales.

F. J. Lewis will continue as a Director of International Combustion Engineering Corporation, of which International Combustion Tar & Chemical Corporation is a subsidiary, and W. H. Lewis will be associated with the corporation in an advisory capacity.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces the appointment of William G. Marshall as assistant to Vice-President T. P. Gaylord. For the past three years Mr. Marshall has been director of personnel for the Philadelphia Company and affiliated corporations, and in his new position he will have charge of employee relations.

July sales of mechanical stokers, as reported to the Department of Commerce by the ten leading manufacturers in the industry, totaled 186 with 65,197 horsepower, as compared with 203 of 67,322 horsepower in June, and 186 of 58,670 horsepower in July, 1928.

Announcement is made by Dean George R. Pegram of the Columbia University Engineering Schools that expansion of the work of the School of Mines has required an addition to its faculty. Dr. Thomas Thornton Read, who has for the past few years served as assistant executive director of the American Institute of Mining and Metallurgical Engineers and as Editor of *Mining and Metallurgy*, will become Professor of Mining. The post of Professor of Metallurgy will be filled by Dr. Eric Randolf Jette, hitherto associate professor of chemistry at New York University. Arrangements are being made for important expansion in research work, which will be under direction of Dr. Read and Dr. Jette.

Combustion Engineering Corporation, New York, formerly represented in the Boston district by Schumaker-Santry Co., has established a district office at 200 Arlington Street, Boston, Mass. J. J. Brady has been appointed district manager, M. E. Yeager, sales engineer, and S. J. Harris, merchandise salesman.

F. L. Farrell and D. F. Jones, formerly of the Schumaker-Santry Company, have associated as Farrell and Jones, with offices at 10 High Street, Boston, and will represent certain accounts formerly handled by Schumaker-Santry Company.

United Light & Power Industries, Inc., has been incorporated in Delaware for the purpose of acquiring or financing small industries in the territory served by the United Light & Power System.

The aim of the company will be to build up industries in the smaller centers of population, thereby increasing the industrial and home use of power in such towns and preventing the movement of workers to the larger cities. United Light & Power Company is said to control the new company.

The Pittsburgh Steel Company, Pittsburgh, Pa., contemplates the erection of a $3,000,000 by-product coke plant at Gibsonton, Pa., to serve its several steel plants in the Monongahela Valley.

Luther B. McMillan

LUTHER B. McMILLAN, thirty-eight years old, chief engineer of the Johns-Manville Corporation, at Manville, N. J., died August 10 as the result of injuries suffered when the plane which he was piloting crashed near the Newark, N. J., Airport.

Mr. McMillan, whose headquarters were in Chicago, was one of the first business executives to use the plane as a method of business transportation. He piloted his own plane, and had covered most of the Western and Mid-Western States in his flights.

NEW CATALOGS AND BULLETINS

Any of the following literature will be sent to you upon request. Address your request direct to the manufacturer and mention COMBUSTION Magazine

Boilers

"Building a Better Box-Header Boiler" presents the new single seam C-E Box Header Boiler. The design of this new boiler is unique in that the butt strap, usually used to join the tube sheet and the hand hole sheet, is eliminated. The flanges of the two sheets are extended and joined by a single row of rivets. The simplicity of the new design is well shown by the illustrations. 4 pages, 8½ x 11—Combustion Engineering Corporation, 200 Madison Avenue, New York.

Cast Iron Storage Tanks

A new bulletin, No. 14, presents the Hahn Sectional Cast Iron Storage Tanks of side discharge, semi-octagonal design, for storing ashes, coal, coke, sand and other materials of corrosive or abrasive nature. The bulletin is well illustrated with line drawings showing application arrangements and details of design. 8 pages, 8½ x 11—Hahn Engineering Company, Division of Lancaster Iron Works, Lancaster, Pa.

Continuous Blow-Off Equipment

A new bulletin, No. 683, describes Cochrane continuous Blow-off Equipment which is offered to maintain proper concentration of solids in the water contained in the boiler. The continuous process corrects the wasteful and inefficient practice of intermittent blowdown. Four application arrangements are shown and described. The subjects of boiler water test equipment and the returning of boiler blow-off to the feed water softener, are also discussed. 8 pages, 8½ x 11—The Cochrane Corporation, 17th Street and Allegheny Avenue, Philadelphia, Pa.

Conveyor Scale

A new bulletin describes the "Telepoise," a simple instrument for weighing material in transit on a conveyor. This conveyor scale indicates registers and records the weight of the material transported. Numerous illustrations show the details of the instrument and its application. 12 pages and cover, 6 x 9—John Chatillon & Sons, 85 Cliff Street, New York.

Feed Water Regulator

"The Copes Register" presents an impressive list of companies using ten or more Copes Feed Water Regulators, showing the number now in use and the number of separate orders placed by each company. Illustrations of interesting applications are included. 16 pages and cover, 8½ x 11—Northern Equipment Company, Erie, Pa.

Ovens

"The Oven Book" is a new catalog which presents Swartwout Metal Insulated Ovens for core and mold baking. Swartwout ovens are adapted to a wide choice of fuels—coal, coke, oil and gas. Electric heating may also be used. The catalog contains many illustrations and a wealth of information on this subject. 52 pages and cover, 8½ x 11—The Swartwout Company, 18511 Euclid Avenue, Cleveland, Ohio.

Oil Burners

Quinn Oil Burning Equipment is illustrated and described in a new bulletin, Q-2. A typical arrangement of a complete installation is shown with each piece of equipment indicated. A description is included of the Quinn Oil Torch, a self-contained heating device, which is recommended for "lighting off" the burners of pulverized fuel installations and for general use wherever a portable heating unit is required around the plant. 8 pages, 8½ x 11—Combustion Engineering Corporation, 200 Madison Avenue, New York.

Power Plant Instruments

"The Power Plant Instrument Data Book" illustrates and describes 105 Applications of Instruments to the steam power plant for measuring temperatures, pressures, flows, liquid levels, CO_2 and speeds. The information is well arranged, and illustrations are used profusely to show application arrangements and details of equipment. 48 pages and cover, 8 x 10½—The Brown Instrument Company, Wayne and Roberts Avenue, Philadelphia, Pa.

Bulletin No. 115-2 presents Foxboro Instruments for use in the power plant. An interesting double page line drawing shows a cross section through a typical modern power plant and indicates the recommended type and location of instruments for measuring, indicating and recording the various temperatures, pressures and speeds. Descriptions and illustrations of each type of instrument are included. 28 pages, 8½ x 11. The Foxboro Company, Foxboro, Mass.

Pressure Control Equipment

A new folder, F-5, presents an application of Hagan control equipment for regulating pressures and effecting an accurate and simple control of pressure reducing valves. One interesting feature of the system is that one regulator can operate a number of valves if necessary, and thus insure the accurate proportional movement of each. 4 pages, 8½ x 11—The Hagan Corporation, 304 Ross Street, Pittsburgh, Pa.

Refractories

Several series of technical bulletins on refractories and refractory furnace linings have been bound in covers, and present comprehensive information on this subject. Charts, formulas and rules are included which should be of definite value to those interested in refractory furnaces. 190 pages, 4½ x 6—North American Refractories Company, Curwensville, Pa.

Refractory Arches and Walls

A new catalog features Standard flat suspended arches and Standard sectionally supported side walls for boilers, kilns and industrial furnaces, 20 pages—The Standard Arch Company, Frostburg, Md.

Reports and Surveys

"Steam Plant Survey" is the title of a new folder which presents the scope and advantages of Austin surveys and reports as applied to either existing or contemplated steam plants. 4 pages, 8½ x 11—The Austin Company, Cleveland, Ohio.

Steel for Boiler Construction

Two bulletins, "Nickel Steel Boiler Shells" and "Alloy Steel for Boiler Construction," are of interest to engineers who are studying the application of alloy steels to steam boiler design. While the data pertain more particularly to locomotive boilers, much of the information is applicable to power station boilers for high temperatures and high pressures. 8 pages, 8½ x 11—The International Nickel Company, 67 Wall Street, New York.

Superheaters

A new bulletin T-19, describes the Elesco Multiple-Loop, Single-Pass Superheater. The application arrangements for various designs of boilers are well shown and both convection and radiant types of superheaters are presented. An attractive double page arrangement has been used throughout the catalog which permits of an effective combination of illustrations and descriptive information. 24 pages and cover, 8½ x 11—The Superheater Company, 17 East 42d Street, New York City.

Valves

A new edition of Bulletin 8-R describes Schutte & Koerting stop, check, non-return and triple duty valves for pressures up to 1,500 pounds. Schutte & Koerting Company, 1150 Thompson Street, Philadelphia, Pa.

Welded Pressure Vessels

"Smithwelded Pressure Vessels" describes the manufacture of welded vessels for high temperatures and high pressures. An interesting series of microphotographs is shown to illustrate the similarity of grain structure between the weld and the steel plate. Considerable test data is included to show the efficiency of Smithweld joints. 12 pages and cover, 8½ x 11—A. O. Smith Corporation, Milwaukee, Wis.

NOTICE

Manufacturers are requested to send copies of their new catalogs and bulletins for review on this page. Address copies of your new literature to

COMBUSTION

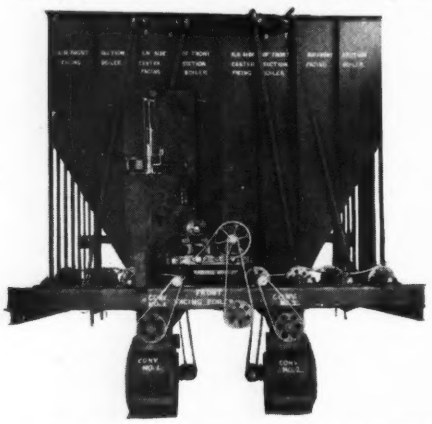
200 Madison Ave., New York

• NEW EQUIPMENT •

A Paddle Wheel Feeder for Wood Waste

For a number of years The M. A. Hofft Company, Indianapolis, Ind., has manufactured a furnace designed especially to burn refuse fuels, either wet or dry, and burn them either alone or with coal.

In order to make this or any other furnace burning a wood refuse work efficiently it is necessary to have an even feed of the refuse without excess air. To accomplish this they have developed an automatically controlled conveyor. Instead of blowing the fuel into the furnace they blow it into a feed bin and feed it out of the bin thru a screw conveyor and paddle wheel feeder. The screw conveyor and paddle wheel feeder are driven by a constant speed motor or a small steam engine running at a constant speed. The amount of fuel fed to the furnace is controlled by the use of a steam control valve which controls a Reeves variable speed transmission between the motor and the screws and which is sufficiently sensitive to hold the boiler steam pres-



sure within two or three pounds. This device feeds the refuse to the furnace as required instead of as it is made, and shuts off all excess air.

The paddle wheel feeder loosens up any lumpy waste before it enters the furnace to prevent puffing and gives a better contact of the air with the fuel. It also prevents the risk of fire getting back of the feeder and the possibility of back-firing into the bin. This is very essential, whether the fuel is burned on the grate or whether the fuel is sufficiently dry and fine to burn in suspension. Proper agitators are built in the fuel bin to prevent any arching of the fuel in the bin.

A High Temperature Pyrometer

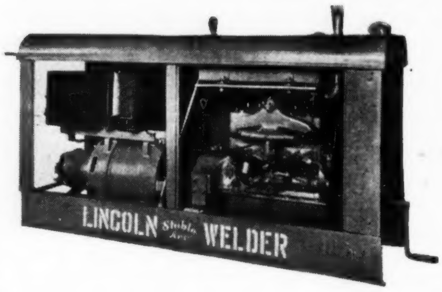
A PYROMETER reading directly to 1200 deg. fahr. has been put on the market by the Roller-Smith Company, 233 Broadway, New York.

The instrument consists of an indicating gage, calibrated to read directly in degrees, a thermocouple which is mounted in a special casing, and flexible leads which are protected by armored tubing. A D'Arsonval-type of milli-voltmeter is used in the gage. Changes in temperature, and cold end differences are automatically compensated for within the instrument, through the use of a magnetic shunt operating on the instrument magnet and actuated by means of a thermostatic device. The armored tubing is attached to the thermocouple, and leads inside the instrument casing, thus protecting the wires against damage which might cause a short circuit.

This instrument is adaptable for any use where the temperature is not over 1200 deg. fahr., and will be found very compact and handy for temperature measurements in and around steam boiler plants.

New Gas Engine Driven Welder Can Be Mounted on a Truck

The Lincoln Electric Company, Cleveland, Ohio, has recently introduced a new model gas engine driven welder for use where electric power is not available. The new model welder is of 200 amperes N.E.M.A. rating



and is powered by a 4-cylinder Waukesha engine, operating at 1500 R.P.M.

The latest improvements which are featured in the new improved models of Lincoln gas engine driven welders are included in this new model. An automatic idling device is incorporated which automatically reduces the speed of the gas engine when welding operations cease, and automatically accelerates the engine to proper speed as soon as weld-

ing is started. It is estimated that this automatic idling device will reduce fuel consumption approximately 25 per cent, as well as considerably reduce wear in the welder which will permit longer life of the equipment.

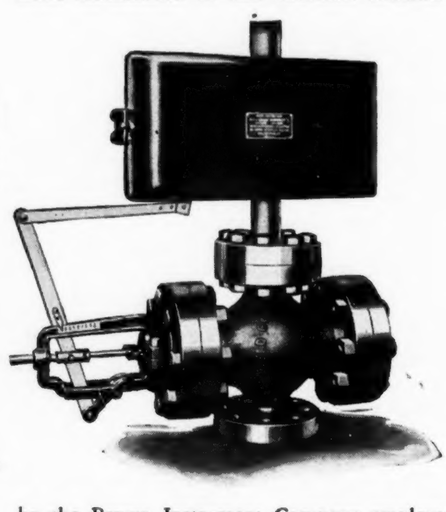
Another feature of this new model welder is the complete protection afforded the machinery by the welded steel canopy totally enclosing the outfit.

Unified control, a feature of all new improved "Stable-Arc" Welders, is also incorporated in this new model. Operating controls are enclosed in a ventilated steel cabinet.

Automatic Flow Control at 1300 Lb. Pressure and 600 Deg. Fahr.

Accurate measurement of flow at high temperatures and high pressures is an important part of the general problem of high pressures now commanding much attention in the field of steam plant design. The automatic control of flow at these high pressures and temperatures, extremely desirable in many applications, adds further complications to the manufacture of flow metering equipment destined to cope with high pressure conditions.

The Brown Instrument Company, Philadelphia, has developed a successful instrument for work of this character dealing with high pressures. The Brown Forged Steel Manometer is used with the Brown Electric Flow Meter, operating on the inductance bridge principle, to govern specially constructed remote control valves. One of the latest installations of this character handled



by the Brown Instrument Company employs the valve shown in the accompanying illustration.

This valve is designed to operate at 1300 lb. pressure and 600 deg. fahr. temperature. Automatic steam flow control has many applications and large possibilities, and is already widely employed to govern the input of steam to process units. The development of automatic steam flow controls that are dependable under severe service conditions opens wide opportunity for advantageous use of equipment of this class for automatically balancing steam output or input between two or more units.

Equipment of this character can be equally applied either to the automatic control of steam, water, oil, air, gas or other fluid. Since the control valve is governed by the operation of an indicating or recording flow meter, within predetermined limits, a record of flow is available for checking the degree of accuracy with which the flow is held within the limits imposed.

PATENTS

Recently granted, and of Interest to our Readers.

Printed copies of Patents are furnished by the Patent Office at 10 cents each. Address the Commissioner of Patents, Washington, D. C.

UNITED STATES PATENTS

Issued July 9, 1929

1,719,831. Two-Zone Pulverizing Apparatus. Fred H. Daniels, Worcester, Mass., assignor to Riley Stoker Corporation, Worcester, Mass., a Massachusetts Corporation. Filed April 12, 1927.

1,719,874. Apparatus for Burning Finely-Divided Coal. William B. Chapman, New York, N. Y. Filed Aug. 18, 1923.

1,719,885. Furnace. William B. Hardway, Cleveland, Ohio. Filed May 16, 1922.

1,719,909. Condensing Apparatus. Max Spillman, Richfield, N. J., assignor to Worthington Pump and Machinery Corporation, New York, N. Y., a Virginia Corporation. Filed Aug. 29, 1925.

1,719,910. Reconditioning Machine. William H. Stinnett, Sugar Land, Texas. Filed May 17, 1928.

1,719,934. Protection Means for Soot-Blowing Elements. David S. Jacobus, Jersey City, N. J., assignor to The Babcock & Wilcox Company, Bayonne, N. J., a New Jersey Corporation. Filed Oct. 15, 1920.

1,719,971. Drum-Mill Feeder. Karl Fahland, Dessau-Grosskuhnau, Germany. Filed July 15, 1927; and in Germany Feb. 18, 1927.

1,719,979. Crushing Machine for Hard Materials. Johannes Ihlefeldt, Dessau, Germany, assignor to G. Polysius, Dessau, Germany, a firm of Germany. Filed June 27, 1927; and in Germany Feb. 4, 1926.

1,719,996. Transfer Device for Finely-Ground Material. Heinrich Peikert, Kalkberge, Germany. Filed June 22, 1927; and in Germany Dec. 2, 1925.

1,720,089. Burner. Thomas E. Murray, Brooklyn, and John H. Lawrence, New York, N. Y.; said Lawrence assignor to said Murray. Filed April 22, 1925.

1,720,090. Boiler. Thomas E. Murray, Brooklyn, N. Y., and Jay A. Freiday, East Orange, N. J.; said Freiday assignor to said Murray. Filed June 25, 1925.

1,720,192. Molding Mixture and Method of Making Same. Archie J. Weith, Evanston, and Otto Holzman, Chicago, Ill., assignors to Bakelite Corporation, New York, N. Y., a Delaware corporation. Filed June 9, 1924.

1,720,214. Drying Apparatus. Alexander Gallerani, Pittsburgh, Pa. Filed Jan. 25, 1928.

1,720,469. Water-Tube Boiler. Percival Francis Crinks, Sidcup, England, assignor to Vickers Boiler Company, Limited, London, England, a Company of Great Britain. Filed June 20, 1927.

1,720,536. Heat Exchanger. John William Young, Manchester, England, assignor to Westinghouse Electric & Manufacturing Company, a Pennsylvania corporation. Filed May 27, 1927.

Issued July 16, 1929

1,720,912. Heat Interchanger. Edward B. McCabe and Guy C. Chamberlin, Carbondale, Pa., assignors to Carbondale Machine Co., Carbondale, Pa., a Pennsylvania corporation. Filed Aug. 1, 1927.

1,720,941. Supporting Harness for Furnace-Arch Walls. John Francis Booraem, Greenwich, Conn. Filed April 1, 1926.

1,720,958. Air-Cooled Furnace Wall. David S. Jacobus, Montclair, N. J., assignor, by mesne assignments, to Fuller Lehigh Company, a Delaware corporation. Filed Sept. 25, 1926.

1,720,973. Firebox Arrangement for Furnaces. Alfred T. Shipstead, Detroit, Mich. Filed Oct. 10, 1927.

1,721,251. Condenser Preheater. Francis Hodgkinson, Swarthmore, Pa.; assignor to Westinghouse Electric & Manufacturing Co., a Pennsylvania corporation. Filed Nov. 27, 1926.

1,721,261. Condenser. John H. Smith, Philadelphia, Pa., assignor to Westinghouse Electric & Manufacturing Co., a Pennsylvania corporation. Filed Oct. 12, 1926.

1,721,267. Arch Brick. James T. Anthony, South Orange, N. J., assignor to General Refractories Co., Philadelphia, Pa.

1,721,287. Condensing Apparatus. Ulrich A. Taddiken, Philadelphia, Pa., assignor to Westinghouse Electric & Manufacturing Co., a Pennsylvania corporation. Filed July 8, 1927.

1,721,289. Disintegrating Machine. Diedrich C. Addicks, Rockmart, Ga. Filed April 8, 1927.

1,721,429. Apparatus for Mixing and Feeding Pulverized Fuel. Ernst H. Elzemeyer and Paul S. Knittel, St. Louis, Mo.; Minnie Elzemeyer, executrix of said Ernst H. Elzemeyer, deceased. Filed June 28, 1923.

1,721,440. Furnace. Ernst H. Elzemeyer and Paul S. Knittel, St. Louis, Mo.; Minnie Elzemeyer, executrix of said Ernst H. Elzemeyer, deceased. Filed July 5, 1923.

Issued July 23, 1929

1,721,556. Measuring Superheat. Thomas R. Harrison, Philadelphia, Pa., assignor to The Brown Instrument Company, Philadelphia, Pa., a Pennsylvania corporation. Filed Feb. 15, 1927.

1,721,594. Classification System for Pulverizing Materials. Harlowe Hardinge, York, Pa., assignor to Hardinge Company, Incorporated, York, Pa., a New York corporation. Original application filed Aug. 28, 1925. Divided and this application filed Dec. 31, 1927.

1,721,735. Reversing and Controlling Apparatus for Heating Furnaces. George H. Isley, Worcester, Mass., assignor to Morgan Construction Company, Worcester, Mass., a Massachusetts corporation. Filed April 28, 1926.

1,721,782. Furnace for Steam Boilers. Eugen Huwyler, Vienna, Austria, assignor to the Firm: Ignis A.-G., Zurich, Switzerland. Filed Apr. 5, 1926; and in Austria June 13, 1925.

1,721,821. Pulverizing Machine. Paul S. Knittel, Jersey City, N. J. Filed May 18, 1927.

1,721,879. Pulverized Fuel Burner. Henry Edward Hazlehurst and Oliver Margetson, London, England. Filed Feb. 13, 1929; and in Great Britain Nov. 20, 1928.

1,721,885. Regenerative Furnace. George E. Rose, Chicago, Ill. Filed Sept. 9, 1922.

1,722,058. Steam Boiler and Blow-Off Device Therefor. John Prentice, Bayonne, N. J., assignor to The Babcock & Wilcox Company, Bayonne, N. J., a New Jersey Corporation. Filed April 10, 1926.

1,722,073. Water-Tube Boiler with Super-Heaters. Benjamin Broido, New York, N. Y., assignor to The Superheater Company, New York, N. Y. Filed Dec. 20, 1925.

Issued July 30, 1929

1,722,495. Producer-Gas Boiler. William B. Chapman, Jackson Heights, N. Y. Filed July 29, 1926.

1,722,496. Boiler and Method of Operating the Same. William B. Chapman, Jackson Heights, N. Y. Filed July 29, 1926.

1,722,700. Fuel Economizer and Smoke Consumer. Anthony J. Hammer, St. Louis, Mo., assignor to William J. Preiss and William H. Preiss, St. Louis, Mo. Filed Jan. 6, 1928.

1,722,785. Boiler having Superheater. Benjamin N. Broido, New York, N. Y., assignor to The Superheater Company, New York, N. Y., a Delaware corporation. Filed Mar. 6, 1926.

1,722,788. Heat-Interchanger Unit for Regenerative Air Preheaters. George C. Cook, Millington, N. J. Filed Oct. 7, 1926.

1,722,826. Air Heater. Josiah H. Rohrer, Philadelphia, Pa. Filed Dec. 12, 1925.

Issued August 6, 1929

1,723,055. Attrition Mill. Robert S. Mechlin, Springfield, Ohio, assignor to The Bauer Brothers Company, Springfield, Ohio, an Ohio corporation. Filed July 5, 1927.

1,723,092. Furnace Lining. Loyd R. Stowe, St. Louis, Mo. Filed Sept. 4, 1926.

1,723,182. Stoker Furnace with Inside Hopper. George A. Kohout, Chicago, Ill. Filed June 15, 1925.

1,723,340. Steam Generation. Paul Faber, Baden, Switzerland, assignor to Aktiengesellschaft Brown, Boveri & Cie., Baden, Switzerland, a Joint Stock Company of Switzerland. Filed Nov. 24, 1926; and in Germany Dec. 4, 1925.

1,723,443. Disintegrating Machine. Ernst Roth, Lautawerk, Germany. Filed Oct. 12, 1925; and in Germany Nov. 1, 1924.

1,723,546. Milling and/or Grinding Machine. Amos Campbell Hamey, North Sydney, New South Wales, Australia. Filed Mar. 24, 1927; and in Australia July 15, 1926.

1,723,675. Furnace Burning Fuel in Suspension. John E. Bell, Brooklyn, and George P. Jackson, Flushing, N. Y., assignors to Combustion Engineering Corporation, a New York corporation. Filed Dec. 7, 1928.

1,723,726. Apparatus for Pulverizing Materials. William T. Doyle, Boston, Mass., a Massachusetts corporation. Filed Nov. 19, 1928.

1,723,771. Feed-Water Heater. Charles G. Duffy, Kansas City, Mo. Filed July 25, 1927.

1,723,905. Superheat Control for Water-Tube Boilers. Harold Edgar Yarrow, Glasgow, Scotland. Filed July 28, 1927; and in Great Britain July 28, 1926.

BRITISH PATENTS

Accepted May 29, 1929

313,021. Improvements in Doors for use on Furnaces, Retorts and the like. Stewart Roy Illingworth, of Glyntaf, Pontypridd, South Wales, and The Illingworth Carbonization Company, Limited, 16, Kennedy Street, Manchester.

Accepted June 4, 1929

312,948. Combined Powdered Fuel and Oil Burner. Harold George Cruikshank Fairweather, 65, Chancery Lane, London, W.C. 2, a communication from The Babcock & Wilcox Company, 85 Liberty Street, New York.

312,972. Improvements in or relating to Burners used in connection with the Burning of Pulverized Fuel. Horace Arthur Marston, The Rosary, Banhill Avenue, Sutton, Surrey.

313,000. Improvements in and relating to Powdered Fuel Burners. Henry Edward Hazlehurst and Oliver Margetson, of 22, Bloomsbury Street, London, W.C. 1.

Accepted June 6, 1929

313,114. Improvements in Heat Exchangers. William Henry Owen, 19 Home Park Road, Wimbledon, London, S.W. 19.

Accepted June 7, 1929

289,079. Means for Regulating Steam Generator Furnaces. Siemens & Halske, Aktien-Gesellschaft, of Berlin-Siemensstadt, Germany.

Accepted June 13, 1929

289,058. Arrangement for Admitting Steam through the Bottom Cover of Vertical Chamber Ovens for Gas Manufacture. Chamber Ovens, Limited, 39 Victoria Street, London, S.W. 1, assignee of Pintsch & Dr. Otto Gesellschaft mit beschrankter Haftung, 71, Andreasstrasse, Berlin, O. 27, Germany.

289,384. Improvements in Furnace Grates. Peder Nielsen Gronborg, 10, Emil Chr. Hansensvej, Copenhagen, Denmark.

292,479. Improvements in or relating to the Separation of Impurities from Circulating Air, Gas or Vapour. Platen-Munters Refrigerating System Aktiebolag, 2, Norrmalmstrog, Stockholm, Sweden.

300,213. Improvements in or relating to Grinding or Crushing Mills. MAG Maschinenfabrik Aktiengesellschaft Geislingen, of Geislingen-Steige, Wurttemberg, Germany.

300,561. Improvements in or relating to Pulverising Apparatus for Solid Fuels and other Substances. George Sylvin Loy, 24, Rue de Liege, Paris, France.

301,513. Improvements in or relating to Boiler Cleaners. Aktiebolaget Superior, 10, Kungstradgardsgatan, Stockholm, Sweden, Assignees of Ateliers de Constructions Mecaniques de Forest Societe Anonyme, Avenue Van Volxen 264, Forest-Brussels, Belgium.

311,312. Improvements in Mechanical Fuel Feeding Devices for Articulated Locomotives. Fried. Krupp, Aktiengesellschaft, of Essen, Germany.

313,225. Improvements in or relating to the Utilization of Pulverulent or Powdered Carbonaceous Materials in Boiler Furnaces. James John Cantley Brand, Australia House, Strand, London, W.C. 2, and Bryan Laing, York Mansion, Petty France, Westminster, London, S.W. 1.

313,241. Improvements in or relating to Smoke Conserving Apparatus for Boiler Furnaces. Alfred Thompson of Wensleydale Mills, Bradford Road, Batley, County of York.

313,245. Improvements in or relating to Apparatus for Pulverizing Coal or other Fuel. John Mullin, 132 Parsonage Lane, Enfield, County of Middlesex.

313,262. Improvements relating to Liquid Fuel Burners. Bernard Powell-Brett, of Bretts Patent Lifter Company, Limited, Foleshield Works, Coventry, County of Warwick.

313,368. Improvements in Pulverized Fuel Burners. Harold Edgar Yarrow, of Yarrow & Company, Limited, Scotstown, Glasgow.

313,380. Improvements in or relating to Furnaces and Furnace Grates. Thomas Owston Wilton and The Chemical Engineering and Wilton's Patent Furnace Company, Limited, 76, Victoria Street, London, S.W. 1.

Accepted June 14, 1929

313,551. Improvements in Furnace Grates. Alfred William Bennis, of Little Hulton, Bolton, County of Lancaster.

313,552. Apparatus for Making Superheater Tube Elements. William Ernest English, of Murton Grange, Bishopston, Swansea, Wales, and John Robert Hannan, of The Elms, Fromley Road, Shortlands, County of Kent.

Accepted June 17, 1929

313,656. Improvements in or connected with Grinding, Crushing, Pulverizing or Disintegrating Mills. Walter Amelius Cloud.

Accepted June 19, 1929

314,323. Improvements in or relating to Underfeed Mechanical Stokers. Alfred Augustus Thornton, 7, Essex Street, Strand, London, W.C. 2.

314,324. Improvements in Variable Speed Gearing for Mechanical Stokers. Alfred Augustus Thornton, 7, Essex Street, Strand, London, W.C. 2.

Accepted June 20, 1929

313,681. Process and Apparatus for the Generation of Steam. Adolf Bartsch, 5, Landsbergerstrasse, Halle on the Saale, Germany.

313,680. Improvements in or relating to Crushing Mills. Ernst Curt Loesche, 60 a, Kaulbachstrasse, Berlin-Lankwitz, Germany.

313,696. Improvements in and relating to Atomisers, Vaporisers, Liquid Fuel Burners and the like. Alexander Magowan, 4 K, Leeds Road, Cutsyke, Castleford, Yorks.

313,780. Improvements relating to Heat-exchanging Devices. Charles McNeil, of Colonial Iron Works, Helen Street, Govan, Glasgow, Scotland.

313,803. Improvements in or relating to Steam Superheaters, Steam Generators and other Tubular Heat Exchange Apparatus. The Superheater Company, Limited, 195, Strand, London, W.C. 2.

313,806. Improvements in or relating to Steam Superheaters. The Superheater Company, Limited, 195, Strand, London, W.C. 2.

313,830. Burner for Liquid Fuels. Jens Christian Nilssen, Risor, Norway.

300,236. Improvements in or relating to Liquid and Powdered Fuel Burners. Bruno Peckelhoff, 54, Barsbuttelerstrasse, Rahlstedt, near Hamburg, Germany.

313,845. Improvements in or relating to Crushing Mills. Ernst Curt Loesche, 60 a Kaulbachstrasse, Berlin-Lankwitz, Germany.

313,844. Improvements in or relating to Crushing Mills. Ernst Curt Loesche, 60 a Kaulbachstrasse, Berlin-Lankwitz, Germany.

Accepted June 24, 1929

284,218. Process and Means for Preventing the Formation of Deposits on Heat Exchange Apparatus Exposed to Hot Gases, and Apparatus obtained thereby.

Accepted July 4, 1929

314,469. Improvements in or relating to the Combustion of Fuel. William Ratcliffe Small, of General Buildings, Aldwych, London, W.C. 2.

314,613. Improvements in or relating to Back Bridges for the Grates of Furnaces. William Gibson, 75 Somerset Road, Newport, Monmouthshire, and Edward James Pocock, of Windermere, Wann-Fawr Road, Rhiwbina, Cardiff.

301,796. Improvements relating to the Carbonizing and Burning of Bituminous Fuel. Humphreys & Glasgow, Limited, 38, Victoria Street, Westminster, assignees of John Morrell Rusby and William Ingram Battin, Philadelphia, Penna.

308,754. Improvements in or relating to Coal Dust Furnaces, particularly of Locomotives. George Hayn, Kassel, Aschrottstrasse 1, Germany.

314,669. Improvements in or relating to Steam Superheaters of the Fire Tube Type. The Superheater Company, Limited, 195 Strand, London, W.C. 2.

292,146. An Improved Method of Operating Industrial Furnaces and Furnaces adapted thereto. Robert Warsitz, 36, Grunstrasse, Hattingen-Ruhr, Germany.

314,664. Improvements relating to Steam Superheaters. Henry Cruse, 48, Stockport Road, Hyde, County of Chester, and Tom Frederick Gray, of Bury; New Road, Kersal, Manchester.

314,624. Improvements in Furnaces. George William Johnson, 47, Lincoln's Inn Fields, County of London, communicated by American Engineering Company, of Philadelphia, Pa.

314,614. Improvements in and relating to the Combustion of Pulverised Fuel and Means therefor. Edward William Green, of Blackwell Yard, London, E. 14; George Rodham Unthank, 84 Albert Road, Alexandra Park, London, N. 22; and David Dunn, 43, Rutland Road, Wanstead, London, E. 11.